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THESIS

Anthracite and Its Competition

by

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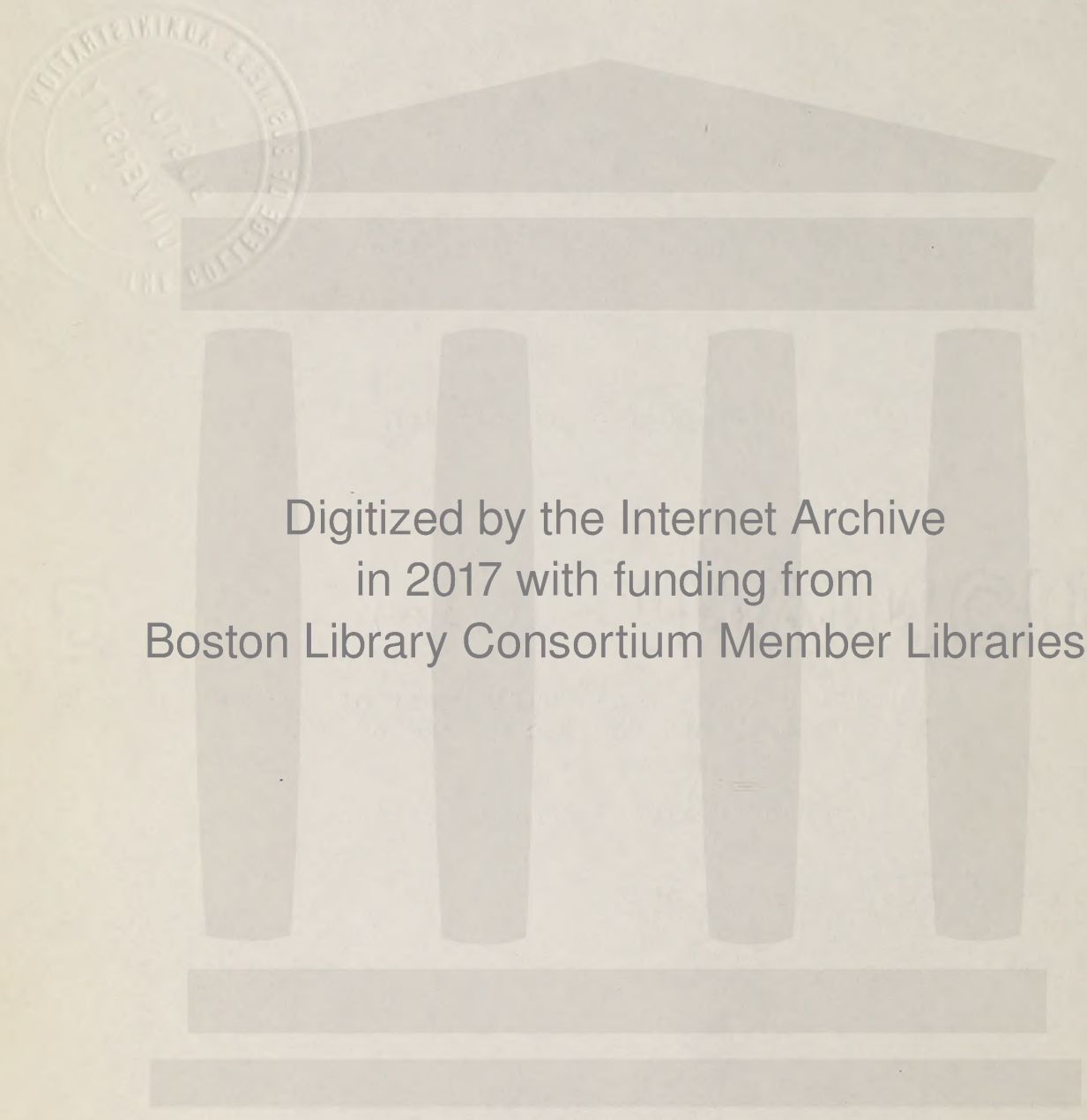

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Anthracite and Its Competition

I. Definition of Terms. Page 1.
- Anthracite
- Petroleum
- Bituminous Coal
- Manufactured Gas
- Coke
- Briquettes or Ovoids
- Foreign Coals
- Oil Coke

II. Economic Importance of Anthracite. Page 5.
- History
  - The origin of anthracite
  - The discovery of anthracite
  - Discovery of its value
  - The use to which the fuel was originally put
  - Uses subsequently made
  - The part anthracite has played in the development of modern industry
  - The place anthracite has taken in modern heating
- Anthracite Production Figures
  - Unites States Imports and Exports of the fuel
  - Value in dollars of anthracite produced in the present century
  - Production tonnage figures for the first few years of the industry
  - Anthracite shipments up to 1927
  - Decrease in shipments from 1927 to 1933

III. Location of Coal Fields. Page 16.

IV. Mining and Preparation of Anthracite. Page 18.
- Primitive Mining of Early Days
- Modern Mining Methods
- Preparing Anthracite for Market
  - Early methods of preparation
  - Modern methods of preparation
- Grading and Standardizing the Product
  - Burning qualities
  - Result of storage
  - Tests and inspection
  - Supervision of testing

Method of testing
Coal below standard
Standards of unscrupulous operators
Sizes
Uses of different domestic sizes

V. Labor at the Mines. Page 33.
The Mine Workers
Mine officials
Other mine employees
Characteristics
Communities
Housing
Stores
Leisure
Wages
Labor Relations
Unions
The great strike of 1902
Anthracite Coal Strike Commission report
The Anthracite Board of Concilliation
"Closed shop" and "Check-off"
Effect of strikes on the cost of producing anthracite
Effect of labor troubles on the consumer's pocketbook
Effect of labor troubles on the market for anthracite

VI. Transportation
History
Turnpikes
Waterways
Railroads
Railroad coal companies
High freight rates and their effect
Justification of high freight rates
Effect of high freight rates on the market

VII. Costs of Producing Anthracite Page 54.
Costs and Margins
Index Figures
Unprofitable Sizes of Anthracite
Taxation of Anthracite

VIII. Channels of Trade Page 61.
Machinery of Distribution
Selling agencies of railroad coal companies
Independent Operators and their marketing methods
Jobbers
Wholesalers and Retailers
The wholesale snowbird
Local wholesale trestle and dock companies
Retailers
Distribution of retail tonnage

IX. Merchandising Anthracite Page 68.
History of Merchandising Product
Early efforts
Modern distributional methods
Analysis of the Product
The advantages of anthracite
The disadvantages of anthracite
Its uses
Research to determine new uses
Analysis of Market
Consuming districts
Sales possibilities from the retailer's point of view
Analysis of Competition
Anthracite vs. oil (petroleum)
Anthracite vs. coke
Anthracite vs. gas (manufactured gas)
Anthracite vs. foreign coals
Anthracite vs. petroleum coke
Anthracite vs. briquettes and ovoids
Discussion of Merchandising Activities
Merchandising by competitors
Coke merchandising
Merchandising of anthracite

X. Effect of Competition Page 115.
Effect on Anthracite Production Figures

XI. Summary Page 116.

XII. Appendix Page 118.

INTRODUCTION

From the time that prehistoric man first discovered fire and its properties of light and heat, the problem has confronted man of selecting the best materials from which this fire might be obtained. I have concerned myself with fire for the purpose of producing heat, and particularly with the fuel with which the fire is made. It is my conviction that anthracite is superior to all its present day competition because of its higher efficiency at a minimum cost.

The problem of selecting the best fuel from the standpoint of heating value, lack of waste, economy and labor-saving is of great importance to the man who pays the fuel bills. An understanding of the history of the fuel, and particularly of the means used to remove it from deep down in the mines, prepare it for market, to transport it to the retailer, to sell it to the consumer, should be had by anone using the fuel. Hence the importance and significance of this treatise on the mining and marketing and the economic advantage of anthracite.

As far as I have been able to ascertain, the values of anthracite, its mining and market, have not been treated frequently or extensively in college thesis research. However, great experimentation, computation, and documentation have been done by the Anthracite Institute which has

felt the need of demonstrating the superior values of their product because of the present competition from other fuels. Many pamphlets, books and other written matter have been issued from this source. These have proved most valuable in supplying references and collateral matter for this thesis.

During the past thirteen years, I have been engaged in merchandising anthracite, consequently I have a great interest in the sales value of this product, its production and marketing.

I have striven to present the project as interestingly as possible, avoiding as frequently as possible the use of technical language. In discussing any proposition it is desirable to have some knowledge of the history of the subjects in question - hence the brief historical narration. In a discussion of coal the idea of its transportation cannot be separated from it, therefore, I have inserted a brief exposition of the means of transportation. Labor troubles have been one of the most important factors in the anthracite industry so I have spent considerable time with that subject.

The problem is to make clear the story of anthracite -- to describe its origin, development, methods of mining and preparation, its human relationships and the competition it meets.

ANTHRACITE AND ITS COMPETITION

I. Definition of Terms

Anthracite:

A. "A hard natural coal, differing from bituminous coal in containing little volatile matter." (1)

B. "The carboniferous remains of prehistoric vegetable matter." (2)

C. "Hard or stone coal, a non-bituminous coal of a shining luster, approaching to metallic, which burns without smoke, with a weak or no flame, and with intense heat. It consists of, on an average, 90 per cent carbon, 3 per cent hydrogen and 5 per cent ash, surpassing bituminous coal in hardness and heat-giving properties. It has some of the properties of charcoal and like that substance, represents an extreme metamorphism of coal under the influence of heat of volcanic disturbance." (3)

(1) Webster's Collegiate Dictionary.
(2) Practical Combustion Engineering Course for Anthracite Salesmen.
(3) Winston's Cumulative Loose Leaf Encyclopedia.

Petroleum:

"Rock oil, mineral oil, or natural oil, a dark brown or greenish inflammable liquid, which at certain points exists in the upper strata of the earth. Petroleum is refined by distillation, yielding gasoline, naptha, benzine, kerosene, lubricating oils, paraffin, fuel oils, etc." (1)

For the purposes of this thesis I shall consider kerosene and fuel oils.

Oil was probably formed by the decomposition of organic matter of marine origin. (3)

Bituminous Coal:

"This class of coal is commonly called 'Soft Coal' and its constituents are fixed carbon and bitumen. The bitumen --- is a mixture of gases, oils and tars, formed by various combinations of carbon and hydrogen. The classification of bituminous coals covers such a wide range, each having different combustion characteristics that space and time do not permit discussion other than in a general way. They range in specific gravity 1.25 to 1.4 and in color from dark brown to

(1) Webster's Collegiate Dictionary.
(3) Winston's Cumulative Loose Leaf Encyclopedia.

Bituminous Coal: (continued)

"pitch black, with varying degrees of hardness. Harder varieties generally have the greatest heat value." (2)

Illuminating Gas:

"A combustible gaseous mixture, used for illumination or for fuel."(1)

There are two main types of illuminating gas - water gas, "gas prepared by passing steam through incandescent carbon" (3), and coal gas, "gas prepared by distilling coal." (3)

Coke:

A. "Bituminous coal deprived of its volatile constituents by heating in a retort or oven." (1)

B. "The carbonaceous residue of coal which has been heated in an oven or retort, or in any way by which little air is admitted until all volatile matter has been expelled." (3)

Briquettes or Ovoids:

Prepared fuels made from coal in a powdered condition. The coal after being washed is

(1) Webster's Collegiate Dictionary.
(2) Practical Combustion Engineering Course for Anthracite Salesmen. (Lecture 2, page 2.)
(3) Winston's Cumulative Loose Leaf Encyclopedia.

Briquettes or Ovoids: (continued)

mixed and ground with tar, pitch or other binding material in the proportion of about 90 parts of coal to 10 of the binder. The mixture is then melted and molded into egg shapes or sofa pillow shapes in sizes easy to handle.

Foreign Coals: (Welsh, Russion and Scotch hard coals.)

They are not as hard as the true anthracite. They are compact, black and shiny. They contain a higher percentage of gaseous matter and ignite more readily than anthracite. Combustion takes place freely and produces intense heat. (2) They are more friable than the Pennsylvania product, consequently there is considerable degradation in shipment.

Oil Coke:

Usually known by the trade name of "Petrokarbon", is the carbon remaining from the distillation of petroleum.

(2) Practical Combustion Engineering Course for Anthracite Salesmen. (Lecture 2, page 2.)

II. ECONOMIC IMPORTANCE OF ANTHRACITE

History

The origin of anthracite.

Some millions of years ago our story begins. At that time northeastern Pennsylvania was a vast swamp. Alternately the area sank below the level of the sea and rose above it. Curious giant plants filled the swamps with a thick tangled growth. Forests, far more luxuriant than our densest tropical jungles, flourished where the hills of Pennsylvania now rise. The steaming heat of the sun created jungles so impenetrable that only amphibians and insects could exist.

Alternately flooded with sunshine and drenched with warm rains, the vegetation stored up the sunshine and the soil elements into vast quantities of carbon - the chief element of coal. (1)

"Fronds and leaves and reed-like plants would fall to the ground, to decay and to fertilize and quicken the growth of dense and yet denser vegetation. Rivers would pour into the valleys, heap silt upon the fermenting deposits of vegetable matter. (2)

(1) Buried Sunshine. Pages 1 to 8.
(2) Mac's Directory and Handbook of Anthracite. Page 3.

"Then the agonies of a world in the making drew this jungle beneath the sea for a period; centuries later to cast it, a muddy barren surface, once more into the sunlight. Packed deep below the mire was the fallen jungle of the last period of vegetation.

"Another jungle quickly grew, accumulating its mass of decayed fronds and reeds. For ages and ages pithy trees and curious plants multiplied in the humid sunlight.

"Again and again the process was reenacted, the surface rising above and falling beneath the tepid seas with the convulsions of the earth.

"In the course of time dry land remained dry. But the crust of the earth had not yet found its shape. Earth shrinkage tumbled the surface into confusion, today's mountain becoming tomorrow's valley. Unimaginable pressure, with its accompanying heat, crushed down upon the buried layers of vegetable matter which once were jungles.

"Sand was pressed into rock, silt into slate. And in between the layers of rock and slate, the fronds and leaves and reeds of the ancient jungles were pressed into a black, brittle substance which millions of years later was to become the most satisfactory household fuel known to man. (1)

(1) Mac's Directory and Handbook of Anthracite. Page 3.

"Anthracite is almost pure carbon. Nature squeezed and distilled the volatile out of it. That is why hard coal burns steadily, evenly; why it holds its heat within the fire box in the process of combustion, instead of wasting it as hot gases up the stack; why anthracite just cannot, no matter how or where you burn it, create smoke and soot." (1)

The discovery of anthracite.

Tradition tells us that between 1750 and 1755, a few Indians near Nazareth, Pennsylvania, knew that anthracite would burn, and there is evidence that in 1763 'stone coal,' as anthracite was then called, was regarded as having value. (2)

Traditions also tells us the story of a hunter named Neccho Allen who was roaming the back country of Schuylkill in search of game. Night fell, and he built his camp fire under a shelter rock and went to sleep.

"Later, he was awakened by an intense heat to find that his fire, built on an outcrop of anthracite coal, hand kindled the very ground beneath him." (3)

So finally came the knowledge of the greatest anthracite fields in the world. (3)

(1) Mac's Directory and Handbook of Anthracite. Page 3.
(2) The Story of Anthracite. Page 21
(3) Buried Sunshine. Page 12.

Discovery of its value.

"Primitive conditions were in existence at the time of discovery of this fuel. Railroads had not come into existence at that time. Transportation facilities consisted chiefly of ox-drawn carts over roads deep with mire. Canals were being considered but had not become a factor in transportation." (1)

Wood was plentiful and was the fuel used by most people of that age because of its abundance and consequent inexpensiveness. Anthracite was used little by people of that era as a fuel, and it was not until half a century later, during the industrial expansion that anthracite came into its own.

An event occurred, in 1769, which was almost as notable as the discovery of anthracite itself. Prior to that time hard coal had been given little thought as a fuel because of the difficulty in igniting it and in maintaining combustion. This probably accounts for its being called 'stone coal.' In that year, however, Obadiah Gore, a Yankee blacksmith, successfully burned anthracite in a forge. Following this demonstration of the burning qualities of anthracite it came into general use by blacksmiths in the Wyoming Valley. (1)

In 1788, Judge Jesse Fell of Wiles-Barre, used anthracite in his nailery. In February, 1808, he successfully burned it in a grate, of which experiment he made a

(1) The Story of Anthracite. Chapter III. Page 24.

note as follows: "Feb. 11, 5808 of Masonry, made the experiment of burning the common Stone Coal of the Valley in a grate in a common fireplace in my house and find it to answer the purpose of fuel, making a clearer and better fire at less expense than burning wood in the common way."(1)

The use to which the fuel was originally put.

Although the industrial uses of anthracite are important today, they were of even greater relative consequence in the early period of its production. Gradually anthracite displaced wood as a fuel for the fireboxes of steamboats and locomotives. (1)

Anthracite was used in iron working as early as 1812. Probably the most important industrial use of anthracite was as an agent for smelting iron ore. Until after the middle of the last century anthracite was the chief fuel for that purpose.

Uses subsequently made.

Anthracite is used in the manufacture of water gas, so important for household purposes, but it is as a source of heat for home, office and factory that it stands supreme. This clean, smokeless combustible was early recognized as an ideal fuel for the home. The smaller sizes still constitute an important supply of steam-producing fuel for manufacturing purposes.

(1) Mining Congress Journal, July 1930. Page 551.

The part anthracite has played in the development of modern industry.

"The second quarter of the nineteenth centruy witnessed a great expansion in the application of steam power,derived from coal burning, and the smelting of iron. At the close of that period, the United States had attained second place among the nations of the world in coal production with an annual output of more than seven millions of tons. (Today there are a number of companies each having a greater annual output than this.) Coal, and anthracite in particular, was becoming constantly more important as a source of the nation's power, and as a factor indispensable to its industrial growth. The production of coal rose from fourteen million tons in 1860 to two hundred and forty million tons in 1900, and to more than six hundred million tons in 1920. This enourmous increase in the production of coal was coincident with unparalleled industrial expansion, and the latter was, in a large measure, dependent upon the former. Without coal, it is safe to say that the industrial achievments of the present age would never have crossed the threshold of accomplishment." (1)

The place anthracite has taken in modern heating.

From an insignificant beginning, anthracite has developed into the most important fuel for domestic heating in the New England and Atlantic States. It has led to the development of modern heating systems, manufactured for the purpose of burning anthracite.

(1)The Story of Anthracite. Page 108. The Hudson Coal Co.

Anthracite Production Figures

United States imports and exports of the fuel.

Anthracite at one time enjoyed a considerable foreign trade, most of the exports being to our northern neighbor, Canada, and the most satisfactory years being between 1910 and 1923. In ordinary years, the quantity of exports to Canada was between three million and five million tons annually. Since 1923, the export business has fallen off steadily, and in 1933 amounted to only 1,429,829 net tons.

It has only been in the last fifteen years that imports of anthracite into this country have assumed any special importance. Attracted, however, by the higher prices of anthracite some European countries have found it profitable to pay the carrying charges,and in some cases import duties, and have consequently disrupted to some extent the market of American anthracite, particularly in New England, into whose ports most of the foreign anthracite is shipped. Imports are received chiefly from Soviet Russia and Great Britain, the former having considerably the advantage. See Appendix A for details.

"Mac's Directory of Anthracite" has this to say about United States Imports and Canadian Imports. "Total imports of anthracite into the United States have evinced a distinctly downward tendency since 1930, on an annual basis, culminating in a decrease of 24.8% from 607,121 net tons for the 12 months ended December 31, 1932,

to 456,251 net tons for the corresponding period in 1933. Imports of British anthracite have also declined steadily since 1930, with the exception of a peak in May of 1932, to a level of approximately 200,000 net tons for the 12 months ended December 31, 1933. Imports from Russia, however, attained a level just under 250,000 net tons in 1931, and have varied but little since that time. Anthracite imports from Germany and Belgium, the latter believed to be of German origin, achieved rather menacing proportions in 1932, but have since become a negligible factor in the total." (1)

The decline of British imports in recent months may, to some degree, be attributed to the devaluation of the American dollar; that Russion imports do not also seem to reflect this condition is probably due to the fact that the ruble is not actively traded in.

Details of imports for the twelve months ended December 31, 1933, by import districts, may be found in Appendix B.

"Imports of anthracite into Canada, as reported by the Dominion Bureau of Statistics, for the calendar year 1933, totaled 3,035,613 net tons as compared with 3,138,427 net tons in 1932, a decrease of 3.3%. Imports from the United States amounted to 1,429,829 net tons in 1933, and 1,685,532 net tons in 1932, a loss of 15.1%. Great Britain's proportion of the total has been almost steadily on the

(1) Mac's Directory of Anthracite. Page 17.

increase since the "Buy British" movement and the Ottawa Conference, with the result that British imports constituted 52.9% of the total for the calendar year 1933. Imports from the United States, on the other hand, represented 47.1% of the total, indicating an almost complete reversal of the relative positions of the United States and Great Britain since the end of the calendar year 1932, when the United States supplied 53.7% of the total and Great Britain 44.6%." (1)

Recent developments in international exchange have given the United States an advantage over Great Britain in the Canadian market. This condition may be expected to lead to increased sales of American anthracite in Canada upon the depletion of present inventories.

Value in dollars of anthracite produced during the present century.

The details of the value of anthracite produced in the present century will be found in Appendix C.

It will be seen that the quantity produced was not always a measuring stick for the value of the year's production, due, obviously, to the change in average value per net ton. For example, the year 1917, although showing the largest quantity production figures for the present century, does not show the greatest value of production.

(1) Mac's Directory of Anthracite. Page 17.

Another salient fact about these figures is the low relative figures for the years 1902, 1922, 1925, the years of the strikes in the anthracite fields.

Another noticeable feature of this table is the steady increase in value per net ton up to the year 1925, and then the steady decline in value to 1934.

Production tonnage figures for the first few years of the industry.

The first record of production in the anthracite region was in 1807, when 55 tons were reported as having been shipped. There are no exact records as to production between that time and 1820, but it has been estimated that about 12,000 tons were produced between these two dates. These shipments were principally from the Wyoming or Northern Region. (1)

The Lehigh Region, however, receives the credit for the first really commercial production, what is now the Lehigh Coal and Navigation Company having in 1820 shipped down the Lehigh and Delaware rivers 365 gross tons, or one ton for each day of the year. (1)

Anthracite shipments up to 1927.

A study of Appendix D will reveal the fact that beginning with the year 1907 and ending with the year 1927 anthracite shipments have been fairly constant. Of course, during the strike years of 1922 and 1925 shipments dropped

(1) A Catechism of Anthracite.Page 17.Anthracite Institute.

off due to failure to produce. But aside from these two years, the fluctuations in shipments have not been great.

Decrease in shipments from 1927 to 1933.

For the past several years, shipments of anthracite have suffered a steady decrease, reaching serious proportions in 1932 when the total of 38,313,958 gross tons showed a loss of 18.2% as compared with the shipments for the year 1931. During 1933, however, there has been a definite check in the downward trend, with the result that the total of 38,647,846 gross tons for the calendar year 1933 indicates a gain of .86% as compared with the year 1932.

III. LOCATION OF COAL FIELDS

"In 1749, the Proprietary Government of Pennsylvania purchased from the Indians of the Six Nations a section of land about 125 miles long by 35 miles wide, for the sum of five hundred pounds, or about $2,500. This section comprised practically all the anthracite fields. Considering the vast natural wealth conveyed for so small a consideration, this transaction is indeed, comparable to the similar purchase of Manhattan Island for $24." (1)

"The total area containing workable beds of anthracite is only 484 square miles in extent, or about one thousand times smaller than the area of the bituminous coal fields of the United States. Probably no area of such small extent has had so profound an effect on the industrial development of a country as this small section of Northeast Pennsylvania, the source of the world's richest fuel.

"It is divided geographically into four distinct, canoe-shaped fields, all having their greatest length in a northeasterly to a southwesterly direction. Although separated, these fields are adjacent, all lying in the northeastern part of the state, and within the nine counties of Wayne, Susquehanna, Lackawanna, Luzerne, Carbon, Schuylkill, Columbia, Northumberland and Dauphin. Their respective areas are as follows:

(1)The Story of Anthracite. Page 12.The Hudson Coal Co.

Northern Field	176	square miles
Eastern Middle Field	43	" "
Western Middle Field	94	" "
Southern Field	181	" "
Total	484	square miles " (1)

For trade purposes, however, these fields are divided into three regions, namely, the Wyoming, Lehigh and Schuylkill regions. The Wyoming region comprises the Northern Field. The Lehigh region embraces the Eastern Middle Field and the Schuylkill region includes the Western Middle and Southern Fields. (2)

(1)The Story of Anthracite. Page 12.The Hudson Coal Co.
(2)A Catechism of Anthracite. Page 16. Anthracite Institute.

IV. MINING ANTHRACITE

Primitive Mining of Early Days

Early methods of mining were exceedingly simple. Most of the mining consisted of merely quarrying the outcrops, usually driving on a slight incline to facilitate drainage. The apparent richness of the deposits invited waste. The presence of anthracite deep below the surface was unsuspected. Indeed, even had it been known that there were vast stores of wealth far beneath the earth's surface, there were no means for bringing it up above ground. Increased demand for the product and the exhaustion of the exposed deposits forced the simple, wasteful mining methods of earlier days to give way to the highly organized operations of the present. (1)

In the early days of anthracite mining, when it was no longer possible to secure coal from a given outcrop, a small pit was sunk to a depth of from thirty to forty feet, from which the coal was brought to the surface by means of a windlass worked by hand. When the coal and water accumulated at the mouth of pit so that removal could no longer be safely or economically removed, then the pit was abandoned. (1)

(1) The Story of Anthracite. Pages 111 and 112. The Hudson Coal Co.

Modern Mining Methods

Contrast the modern mining methods with the crude efforts of earlier days. Today, armies of workers wrest these resources from Mother Nature by scientific processes whereby the greatest efficiency is attained.

Mines of today, producing say 2500 to 3000 tons per day will have as high as twenty-five to thirty miles of electric trolley tracks. Entire forests of timber are used to brace up the roofs of the mines to prevent coal from breaking and dropping on the men. Approximately one-half billion board feet of timber are used in anthracite mines in one year. Eighteen tons of water, on an average, are taken away by an enormous pumping system for every ton of coal mined. Approximately one-quarter of a ton of air is pumped into the mines for ventilating purposes for every ton of coal shipped, and it takes a lot of air to weigh a quarter of a ton. (1)

When the coal is to be found near the surface, the method of mining, called stripping, which is similar to quarrying is used. Mechanical shovels remove the soil and rock overlying the bed of coal. The layer of coal thus exposed is blasted in the usual way and loaded into the cars for transportation. (2)

(1) Mac's Directory of Anthracite. Page 29. Coal Information Bureau.

(2) The Story of Anthracite. Pages 143 and 144. The Hudson Coal Co.

The side of a hill may be the point of attack, the bed of coal inclining upward. This is known as a drift. Gravity moves the cars out into the open. Still another hillside operation may decline down into the earth. This is known as a slope. Winch and cable apparatus is required in such instances to bring loaded cars into daylight. (1)

Perpendicular shafts equipped with elevators are used in most operations. A shaft will usually tap several beds of varying depths, some of them horizontal, others lying at an incline, up or down. In mining practice, the term 'tunnels' is applied to horizontal passageways with one or no openings to the surface.(2)

At various points along such tunnels, beds of coal are tapped, and the product is conveyed to the cars. Coal is loaded into the cars by gravity if the offshoot is upward. Any long, horizontal deposits will be followed by rails, which form branch lines of the transportation system. (2)

Large rooms of coal are hewed out below ground, walls or pillars of coal being left to support the ceiling. Finally, even these pillars of coal are removed, the roofs allowed to cave in and the room is abandoned forever. (3)

(1) The Story of Anthracite. Pages 115 and 116. The Hudson Coal Co.
(2) The story of Anthracite. Page 112. The Hudson Coal Co.
(3) The Story of Anthracite. Pages 120 and 133. The Hudson Coal Co.

Preparing Anthracite for Market

Anthracite may truly be termed a manufactured product, the coal as it comes from the mine being the raw material. Nearly two-thirds of the workers at the mine are engaged in the preparation of the product. (1)

Anthracite comes to the surface in large pieces and mixed with rock or slate. These big lumps must be broken into salable sizes, and all impurities must be removed.

Early methods of preparation.

"Up to 1840 all the coal had been shipped as mine run, and a common sight in Philadelphia, was a householder breaking the coal on the street in front of his house. John G. Hines, of Pottsville, a visitor to the city, observed this. He conceived the idea that this work should be done at the collieries, and the dust and fragments, too small to use in the heating apparatus of the time, should be screened out.

"At his suggestion, a revolving screen, run by steam power, was erected at Port Carbon, the coal being broken by sledges, at first on wooden platforms and then on perforated iron plates. In 1845, the breaking of coal by machinery was begun, the machine being capable of

(1) The Story of Anthracite. Page 146. The Hudson Coal Co.

breaking 200 tons a day. But, as that did the work of 40 or 50 men, it was an economic success. ---- From 200 tons in a 10 or 12 hour day for the first breaking machine in the Schuylkill region to 5,000 tons in an eight hour day is quite a step." (1)

In the early days, slate was removed from the coal by boys who sat astride chutes and picked out the foreign matter as the coal passed them. Picking tables came later. Coal passed over these tables on a horizontal plane at a slower rate, permitting better extraction of impurities.

Modern methods of preparation.

A modern breaker (manufacturing plant) which crushes, sizes and cleans anthracite, costs approximately $2,500,000.00. Producers of anthracite have spent millions of dollars improving their product, in the last few years. New equipment has been installed, and a new preparation process has been developed that definitely and effectively removes all impurities from the coal. (2)

"Modern machinery and efficient production methods have decreased the ash content and increased the B.T.U.'s (British Thermal Unit - the measure of heat content) in

(1) The Mining Congress Journal. July 1930. Page 555.
(2) Mining and Preparation of Anthracite. Page 2. The Hudson Coal Co.

anthracite to such an extent that today the consumer is receiving a dividend of approximately one dollar's worth more heat per ton than formerly." (1)

The 'Jig' method of cleaning anthracite is one of the modern processes. "If a mixture of coal and rock were suspended in a rising column of water, or such a mixture plunged into a stationary body of water, rock would sink first and deepest. The Jig process is an application of that simple principle. A basket of the mixture is either agitated in still water, or the water is caused to wash upward against a basket in a fixed position, so that the result is to hold anthracite at or near the surface, while the rock sinks and thus effects the required separation." (2)

The 'Rheo-Laveur' method is one which is used in many mines today. Its principle is as follows: "If a mixture of coal and rock were tossed into a rushing stream of water, the rock would sink first, and at a spot nearest the point of entering the water, the lighter coal would sink last, and at a point farther on, thus effecting a separation." (2)

Many manual and mechanical means have been used to prepare coal. The most effective and most modern is the 'Chance-cleaning' or 'Sand flotation' process for

(1) Mining and Preparation of Anthracite. Page 2. The Hudson Coal Co.
(2) Mac's Directory of Anthracite. Page 33. Coal Information Bureau.

removing slate from anthracite. The run-of-mine coal enters huge, cone-shaped, metal tanks which are filled with a sand and water mixture. This mixture is kept constantly agitated by large revolving paddles. The density of the mixture is predetermined so as to give a specific gravity slightly greater than anthracite and slightly less than the impurities. The contents of the mine car are dumped into the cone (after the large pieces have passed through the rolls) by means of a chute. The impurities, rock, slate and bone, all contain a higher percentage of ash than anthracite and are heavier than the coal. The coal, therefore, containing less specific gravity than the impurities, floats to the top of the cone and is conveyed along chutes to the sizing screens. The rock, bone and slate,being heavier than the coal, sinks to the bottom of the cone, is trapped and carried away to the refuse dumps. (1)

This principle may be illustrated by throwing a handful of pebbles and splinters of wood into a pail of water. The pebbles, being heavier, will immediately sink to the bottom. The wood, being lighter, floats. Thus the coal being lighter, having less specific gravity, floats; the impurities, being heavier, having greater specific gravity, sink.

(1) Mining and Preparation of Anthracite. Page 13. The Hudson Coal Co.

After the coal reaches the surface, this is what happens: The contents of the mine car are dumped into conveyors and then passed over screens with large perforations which are called 'bull shakers'. The pieces larger than Grate size which do not pass through the perforations are rolled and broken into Grate sizes and smaller. The market for Grate size does not equal the normal production of that size, consequently some of the Grate size is broken into Egg and smaller sizes. A third set of rolls breaks a certain percentage of the Egg size into Stove and smaller sizes according to the demands of the market. The different sizes are carried, by means of chutes, to their respective cones, where the impurities are removed. The sand and silt are washed off the pure coal by cascades of water. By means of screens, the various sizes are segregated and conducted through separate chutes to the loading pockets, from which they are loaded into railroad cars. (1)

(1) The Story of Anthracite. Page 189. The Hudson Coal Co.

Grading and Standardizing the Product

"The Story of Anthracite" relates that there is no sure criterion for scientific grading of coal. "Chemical composition, physical characteristics and heating value have each seemed to offer a basis, but none of them has proved satisfactory." There is sure to be an overlapping among the various grades or ranks. "The boundaries of the principal classifications of coal have never been legally or scientifically defined, and, speaking with scientific accuracy, it may be stated that all coal belongs to one class." (1)

Burning qualities.

"A Catechism of Anthracite" answers the question, 'Is all anthracite alike in burning quality?', somewhat as follows: Conditions under which the vegetable debris was grown and deposited and the heat and pressure to which it was subjected were not absolutely the same, so that different qualities are present in the resultant anthracite of today. When properly prepared, anthracite from one section will contain approximately the same number of heat units as anthracite from another section. Due to the differences in heat and pressure applied to the different sections, however, there is a difference in the burning qualities. "Where the heat and pressure were less the transformation was less

(1) The Story of Anthracite. Page 6. The Hudson Coal Co.

complete. In these areas the coals are not so compact and are free-burning, but where Nature's action was stronger the change was more pronounced and the coals are harder and burn somewhat less rapidly than the free-burning coals." Under conditions of a somewhat slow chimney draft, or when a quick, hot fire is wanted, as in kitchen ranges in the summer time, the free-burning coal is preferred. If the chimney draft is strong, and a long steady heat is desired, then the harder, slower burning varieties can be used to better advantage. (1)

Result of Storage.

Another factor that we may consider in connection with the grading of anthracite is the fact that anthracite does not deteriorate as the result of prolonged storage. "Deterioration of any fuel can occur only by evaporation, leaking, or spontaneous combustion. Since anthracite is not volatile, is insoluble in water, and is not subject to spontaneous combustion, its only evidences of prolonged storage are a slight discoloration caused by the oxidation of the small amount of iron in the ash, and affects only the surface of the individual pieces." A lack of lustre, although making the anthracite less attractive does not affect the heat value, or burning characteristics of the fuel. (2)

(1) A Catechism of Anthracite. Page 3. Anthracite Institute.
(2) A Catechism of Anthracite. Page 2. Anthracite Institute.

Tests and inspection.

Tests, inspections and checks keep pace with preparation of the fuel, so that a carload of coal that is not up to standard is sent back to the breaker for re-preparation. Each piece of coal is not only washed, but literally measured for both size and purity. Due to improved preparation measures, as has already been said before, the high quality of anthracite being shipped to market today is worth, in heat value, approximately one dollar more than the product of a few years ago. (1)

Perfection, for which humans are constantly striving but seldom attain, has not been reached in the removal of impurities but, as nearly perfect a fuel from the standpoint of sizing and cleanliness as is commercially advisable to make has been turned out.

Supervision of testing.

The Hudson Coal Company has its inspection forces under control of the Sales Department, insuring a much more accurate inspection than would be likely if these duties were delegated to the Colliery Superintendent. If the Colliery Superintendent were in charge, it is very likely that he would be satisfied with a more casual inspection. This is true because it costs considerable to send a carload of coal through the breaker again, not only because of the costs

(1) The Story of Anthracite. Pages 196 and 197. The Hudson Coal Co.

of re-preparing the coal but also because a certain amount of breakage occurs, and each smaller size realizes less money per ton in the market than the larger size. Being under control of the Sales Department, the inspectors are not subject to control or susceptible of intimidation by the local operating officials who are responsible for the mining and preparation of the coal. "Thus the inspectors are interested only in seeing that the anthracite loaded into railroad cars for market complies with the strict standards in respect to purity and size." (1)

Method of testing.

"Samples are taken from nine different points in each railroad car. Each of these samples is weighed and then tested on standard hand screens as to size. Doubtful-appearing particles and pieces of slate and bone are segregated and weighed. If the sizing is not in accordance with the standard specifications or the percentage of impurities is greater than that established for the particular size being tested, the contents of the car are condemned by the inspector. The coal is then dumped and sent through the breaker for re-preparation." (2)

(1) The Story of Anthracite. Page 199. The Hudson Coal Co.
(2) The Story of Anthracite. Page 200. The Hudson Coal Co.

Coal below standard.

Thousands of cars are condemned annually because they are not up to the strict standards of the industry. These cars may contain perfectly good coal of excellent burning quality, but if the coal does not meet the standards it is condemned. Although local colliery operating officials may complain of the heavy expense of re-preparing the fuel, their complaints fall on deaf ears. Their only salvation is an adjustment within the breaker that will result in an acceptable product which fully complies with the standards.(1)

Standards of unscrupulous operators.

Every car of anthracite that goes to market is not subject to such rigid inspection methods, however. A few small operators lack the capital and necessary equipment. Other operators, none too scrupulous, often secure the right to mine small tracts of coal lands which are exhausted within a comparatively short time, or producers who sell their product below the market price, are not likely to have such high standards. "The larger, well-known producing companies and many of the so-called 'Independent' operators of established reputation adhere closely to the high standards

(1) The Story of Anthracite. Page 201. The Hudson Coal Co.

set by the industry through its trade association, "The Anthracite Institute," which maintains a corps of independent inspectors who make unannounced tests of the breaker screens and market product of member operators to see that the specifications are being lived up to." No longer is the policy of the coal operators 'the public be damned' it is now 'the public be pleased.' Anthracite is no longer a product which must be purchased, it is now bought for its merits. (1)

Sizes.

Seven sizes of anthracite are commonly sold for use as fuel. Egg, Stove, Chestnut and Pea are released as 'Domestic' sizes, while Buckwheat, Rice and Barley are termed 'Commercial' sizes. Buckwheat is constantly growing more popular as a domestic fuel. It is particularly well adapted for magazine and automatic heaters under thermostatic control.

The sizes of the screens used in the preparation of anthracite for domestic market is shown in a diagram in Appendix S, the coal passing through the larger and over the smaller holes in the screens. Lumps passing openings indicated are given the names specified. These are the sizes of the openings in the screens through which the coal goes in the course of preparation in the breaker.

(1) The Story of Anthracite.Page 201.The Hudson Coal Co.

Uses of different domestic sizes.

Egg coal should be burned in heaters having a firebox 25 inches or more in diameter, providing it can be fired 20 inches deep or more.

Stove coal should be used in fireboxes from 20 to 25 inches in diameter and from 15 to 20 inches deep.

Chestnut coal may be used in any boiler or furnace containing a firepot up to 20 inches in diameter and from 12 to 15 inches deep. Chestnut coal is ideal for most types of kitchen ranges and service water heaters.

Pea coal can be used economically when the boiler or furnace is considerably larger than necessary, or with unusually good draft, also in most boilers and furnaces in mild weather and for banking. If extra care is used in shaking the grates, Pea coal can often be substituted for the larger sizes without changes to the furnace.

Uses of different domestic sizes.

V. LABOR AT THE MINES

The Mine Workers

What manner of men work at producing anthracite, how do they live, and what are the conditions of his daily existence? "The Story of Anthracite" presents a fine picture of the mine workers, and the conditions under which he lives. I have gathered all my information regarding the workers from this source.

Mine officials.

Comparatively few native-born residents were familiar with mining operations at the beginning of the industry. Consequently, large numbers of men were imported from Wales, England, Scotland and Ireland. Italians, Russians, Poles and other continental Europeans appeared on the scene when the industry was fairly well established. "In a representative group of anthracite mine officials one is likely to find many with Welsh names, some Yankee, Irish, English and Scotch and an occasional Italian, Polish or Russian name. So far as it is safe to generalize on any subject, it may be remarked in passing that the Welsh have largely confined their ambitions for advancement to the official staffs of the anthracite mining companies, while

the Irish are more active in union affairs." (1)

Graduates of technical colleges are given two year student training courses to fit them to fill supervisory positions in and about the collieries. The anthracite industry offers fine rewards for the application of technical knowledge and trained intelligence.

"Supervisory positions in the anthracite mining industry require the application of intelligence, mental 'balance' and tact." Remuneration compares favorably with that of other industries' supervisors. The official may work his way up to the position of Colliery Superintendent paying a salary of from $4,000.00 to $10,000.00 a year, depending upon the size and importance of the particular colliery, or to higher executive positions with the company. "Therefore, it is not surprisingthat men of high calibre are attracted to the industry. Knowledge and efficiency are more desirable than brawn in a mine foreman. Bulldozing will not be tolerated by the great majority of present day anthracite mine workers." (1)

Other mine employees.

Miners, laborers and men who fill all positions in and about the mines, aggregating approximately 147,000 in number, are included in the term 'Mine Workers.' "The United

(1) The Story of Anthracite. Page 228. The Hudson Coal Co.

States Coal Commission (1922-1923) found that about 47% were native-born Americans and that of the 53% who were foreign-born, approximately one-half were natives of Poland and Russia." Four-fifths of the workers had been in this country ten years or more and one-third of them owned their own homes when the Coal Commission made its survey in 1922. (1)

Characteristics.

Characteristically independent in spirit, quick to raise his voice in complaint at any real or fancied grievance is the miner of today. Being, more or less, his own boss under ground, constantly exposed to danger, he has become somewhat contemptuous of authority. Then too, the miner of today is well paid which causes him to feel more independent.

Satisfied with his occupation, not seeking nor expecting sympathy on account of the nature of his work, the miner seldom cares to forsake his work for other industries. (2)

Communities.

More than two-thirds of all anthracite employees

(1) The Story of Anthracite. Page 228. The Hudson Coal Co.
(2) The Story of Anthracite. Pages 229 and 230. The Hudson Coal Co.

live in incorporated municipalities or boroughs having a population of 2,500 or more. Communities in which anthracite mine workers live compare favorably with other communities of like size in the excellence of their roads, schools, libraries and other improvements. (1)

Housing.

The houses in which anthracite miners live compare favorably with the residences of workers in other industries throughout the country. Miners are not compelled to live in company-owned houses. The United States Coal Commission has reported that only about ten percent of the employees live in houses owned by mining companies. (2)

Stores.

"Company Stores," originated for the convenience of the miners in the early days of the industry rapidly became the subject of abuse. Pressure was brought to bear upon employees to trade exclusively in company-owned stores. Legislation was enacted prohibiting the operation of such stores.

Today the miner may trade at the department stores of the cities, or the chain stores or the independent store, depending upon his choice. (3)

(1) The Story of Anthracite. Page 231. The Hudson Coal Co.
(2) The Story of Anthracite. Page 233. The Hudson Coal Co.
(3) The Story of Anthracite. Page 236. The Hudson Coal Co.

Leisure.

At the end of his work day, between 1:00 P.M. and 3:30 P.M., the anthracite mine employee may do what he likes with his leisure. He may jump into his automobile, - yes, many of them own their own automobiles - and tour the country, go fishing, to the movies, attend a baseball game, or enjoy any of the many pleasures that are common to all the citizens of our country. (1)

Wages.

Manual labor is well rewarded in the anthracite industry. "The contract miner himself largely determines the amount of his semi-monthly wages. If he needs the money and puts forth the necessary effort to load the maximum number of mine cars his wages will be high - as much as $20 per day - but if he is satisfied with earnings of from $8 to $12 per day, he adjusts his efforts accordingly. ---- The United States Coal Commission found that the average annual earnings of contract miners employed at 216 collieries during the year 1921 amounted to $1,922. This amount, by adding the 10% wage increase granted in 1923, would be equivalent to present annual average earnings

(1) The Story of Anthracite. Page 236. The Hudson Coal Co.

of $2,114." This explains why the mine employee is generally satisfied with his job and does not look upon himself with the pity frequently expressed by residents of other communities. (1)

The attention of the reader should be called to the fact that the contract miner is among the more highly paid of the miners, however.

I do not want to create the impression that the miner lives in a Utopia of easy work, high wages and ideal conditions, because this is not true, but I do want to correct the prevalent impression that the anthracite miner is a downtrodden, dissatisfied worker.

(1) The Story of Anthracite. Page 238. The Hudson Coal Co.

Labor Relations

Unions.

The Bates Union was probably the first of the unions to organize the mine workers. It was organized in 1848, sponsored a strike or two and was wrecked when the president absconded in 1850.

The Workingmen's Benevolent Association was chartered July 23, 1868. An attempt was made by this organization to limit the production, so that prices would go higher and the miner get a fair day's pay for a fair day's work. This association attained great influence, particularly in the Schuylkill region, and its leaders were able to dictate prices and conditions to the mine owners. In fighting a wage reduction of 30% in 1870, this association lost the strike and with it most of its influence. (1)

The Miners and Laborers Amalgamated Association and the Knights of Labor united in 1887. A strike, begun in November 1887, terminated in a victory for the operators, definitely ending the influence of these two organizations in the anthracite fields.

The failure of these strikes may be laid primarily to the jealousy and the keen competition existing between operators of different fields. (2)

(1) The Story of Anthracite. Page 240. The Hudson Coal Co.
(2) The Story of Anthracite. Page 242. The Hudson Coal Co.

This feeling was shared to a large extent by the workers. One field would be out on strike while another field would continue working and supply the market demand. (1)

The Molly Maguires was a secret organization which terrorized the anthracite region between 1862 and 1875. Its members attacked company officials and faithful employees, wrecked company property, and in general created great disturbances.

It can readily be seen that the unions seemed to attempt to justify their existence by declaring strikes, which in every case, thus far considered, resulted in the disruption of the unions. It may be said in defence of the unions that the operators made few voluntary advances in wages during the latter half of the nineteenth century. Perhaps the union officials thought that the only course left open to them was suspension of work.

The United Mine Workers of America organized the anthracite fields in 1897. In 1900 they called a conference to which they invited the mine operators to attend and discuss and adjust various grievances. The mine operators ignored the invitation. A general strike was ordered to become effective September 17, 1900. It was successful,

(1) The Story of Anthracite. Page 242. The Hudson Coal Co.

the mine operators granting an increase of 10% in wages after forty days of suspension. (1)

The great strike of 1902.

The great strike of 1902 was fought over the following demands:

"1. An increase of 20 per cent upon the rates paid during the year 1901 to employees performing contract or piece work.

2. A reduction of 20 per cent in hours of labor without any reduction of earnings for all employees paid by the hour, day or week.

3. The incorporation in an agreement between the United Mine Workers of America and the anthracite operators of the wages which shall be paid and the conditions of employment which shall obtain, together with satisfactory methods for the adjustment of grievances which may arise from time to time, to the end that strikes and lockouts may be unnecessary." (1)

In October 1902 when the strike had been in effect for five months, President Roosevelt intervened and forced the operators to submit the matters in dispute to a commission which he would appoint.

(1) The Story of Anthracite. Page 244. The Hudson Coal Co.

I am discussing the strike of 1902 in detail because the award of the Anthracite Coal Strike Commission of that year laid the foundation for all subsequent wage agreements between the operators and the mine workers and forms the basis of the agreement governing labor relations within the industry today.

Anthracite Coal Strike Commission report.

"The commission found that the prevailing rate of wages was not lower than that paid in other occupations requiring equal skill and training. Nevertheless, in view of the interruptions incident to mining operations, the increased cost of living, the inequalities of physical conditions and the hazardous nature of the employment, the commission awarded a 10 per cent increase in the rates paid to contract miners.

"The award provided that men employed on an hourly basis should thereafter be paid on the basis of a 9-hour day, receiving the same wages previously paid them for 10 hours. In addition, the award provided for a sliding scale of wages based upon the price of anthracite at tidewater, which resulted in an average wage increase of 4.2 per cent."(1)

(1) The Story of Anthracite. Page 247. The Hudson Coal Co.

The Anthracite Board of Conciliation.

The Anthracite Board of Conciliation was created by the Anthracite Coal Strike Commission and an orderly method for the adjustment of grievances arising during the term of a wage agreement was proposed. If carefully and consistently followed, this plan would render strikes unnecessary during the term of a wage agreement.

At the present time the way it operates is as follows:

"If an anthracite mine worker feels that in any particular he is not being accorded the rights or privileges due him under the wage agreement, whether it be in connection with his rate of wages, working conditions or any other circumstance involving the conditions of his employment, he first takes up the matter with his immediate foreman. Thereupon, if a satisfactory adjustment is not effected, the question at issue is taken up with the colliery superintendent by the local grievance committee, a subdivision of the union organization composed of men employed at the particular colliery. In the event that the question involved is not settled to the satisfaction of the complainant by the local colliery officials, the matter may be taken up by the grievance committee - assisted by the mine workers' member of the Board of Conciliation from their district, or by his representative - with the higher

officers of the producing company. If an agreement satisfactory to the complainant is not then reached, the question at issue may be referred to the Board of Conciliation. A majority decision of the Board of Conciliation is final and binding upon both parties to the controversy and in the event that the Board is evenly divided - as frequently occurs - the matter is submitted to the umpire, whose decision is final. The award of the Board of Conciliation or the umpire, as the case may be, is retroactive to the date the grievance was first taken up by the complainant." (1)

"Closed shop" and "Check-off."

One of the issues of the strike of 1902 was to establish a "closed shop." This appeal was refused by the commission. Their decision, in effect, established the "open shop" although practically all the men employed, with the exception of clerical workers and supervisory officals, are members of the United Mine Workers of America.

There followed a succession of wage agreements from 1903 to 1922, involving wage increases, discussion of the closed shop, and an effort by the miners to have the "check-off" system installed. Cessation of work occurred for short intervals between these two dates due to minor

(1) The Story of Anthracite. Page 248. The Hudson Coal Co.

strikes. It was not until 1922 that a serious strike became effective, however. At that time the suspension of work lasted 163 days. Then came the short strike of 1923 to establish the "check-off" system, and finally came the most disastrous strike of them all, that of 1925, which lasted 170 days.

The "check-off" system consists of a means of collecting union dues, fines and assessments from mine workers by the mine operators.

Effect of strikes on the cost of producing anthracite.

The operators estimated in 1922 that if they granted all the provisions demanded by the mine workers the cost of producing anthracite would be increased at least $3.00 per ton. (1)

"Wages in the anthracite industry have not, as in other industries, receded from the inflated wartime levels, but have, on the contrary, been increased, the mediation of Governor Pinchot in 1923 having imposed an additional burden of 10 per cent on an already burdensome labor cost." (2)

The industry is endeavoring to overcome these handicaps by increased mechanization and by stringent economies.

(1) The Story of Anthracite. Page 270. The Hudson Coal Co.
(2) The Mining Congress Journal, July 1930. Page 557.

Effect of labor troubles on the consumer's pocketbook.

Any increase in the cost of production is almost always reflected in an added tax on the consumer's pocketbook. So, although the miner has had to pay for his tendency to strike, in the form of lost wages; and while the operator has had to pay in the form of lost production; it is Mr. Consumer who pays the increased costs of production.

Effect of labor troubles on the market for anthracite.

Operators have had to stand by during the strikes of 1922 and 1925 and see their market being swamped with substitutes. Competetive fuels, which gained a strong foothold during the strike of 1925 when it was impossible to secure anthracite, have striven to maintain their place. Coke and oil have firmly entrenched themselves as the fuel for domestic heating in many homes, perhaps never to be supplanted again by anthracite. Improved preparation, intensive sales efforts, and efficient service rendered co-operatively by producers and dealers have recovered part of the lost market. (1)

(1) The Mining Congress Journal, July 1930. Page 557.

VI. TRANSPORTATION

History

Turnpikes.

Turnpikes failed as a means of solving the problem of cheap transportation in the early years of the nineteenth century. They were superseded by water transportation.

Waterways.

Canals and rivers were the means used to transport anthracite for a score of years, but when the industry reached its majority, a more effective means of moving the fuel was sought. Water transportation lacked mobility. They could only deliver to points along the route of the waterways and only during favorable seasons. If a yard ran out of coal in the winter months, no more was to be had until navigation opened. In the spring when the ice melted, damaging floods were likely to occur, and in the summer there was often a shortage of water. Industry also demanded more speed than was possible by the horse-drawn boats. Thus was the stage set for the advent of the railroad. (1)

Railroads.

Beginning with the year 1830 the era of railroad

(1) The Mining Congress Journal, July 1930. Page 553.

building began in earnest. The first shipments of anthracite by railroad was made from the collieries to the canals, and for the next few years all the shipments were made from mines to navigable waters. In 1842 the Philadelphia and Reading Railroad completed its railroad to Philadelphia and the first all-rail shipment of anthracite to tidewater was made. Today most anthracite is shipped all-rail direct to the retailer's yard. (1)

State credits aided the railroads, and the bogey man of railroad ownership by coal companies had not yet risen to frighten timorous politicians. Such ownership, on the contrary, was fathered as a fine means of helping develop a valuable natural resource. The Delaware, Lackawanna and Western Railroad was, by its charter, authorized to mine, purchase and sell coal as well as to transport it.

Railroad coal companies.

"The co-ordination of the mining and transportation interests in the early days of the anthracite industry was essential to its economic development." Abuses, such as discrimination in freight rates, car distribution, etc., against operators not affiliated with the railroad interests, crept in, however. Charges that the association of mining interest and carriers were "Creating and fostering

(1) The Mining Congress Journal, July 1930. Page 553.

a monopoly" were broadcast by the politicians, and met a receptive public mind. (1)

Governments that had previously helped the industry now turned on it with a bombardment of investigations, litigation, and legislation. "During a period of 10 years from 1914 to 1923, inclusive, the anthracite industry was subjected to no less than 14 investigations --- and it is worthy of note that in not a single case had anything been found to have reacted unfavorably or prejudicially to the public." In 1915, railroad ownership or control of coal mining operations was attacked by the Federal Government in the famous Reading case and in 1921 the decree was issued which segregated the mining interests from the transportation interests. (2)

High freight rates and their effect.

Anthracite which is shipped all-rail arrives at the dealer's yard with far less degradation due to breakage than coal that is brought in by tidewater. Therefore, retail dealers prefer to receive their coal all-rail, in spite of the much cheaper water freight rates.

Approximately 75% of all Pennsylvania anthracite consumed today in New England is transported by all-rail method, the other 25% being carried by rail and water, the

(1) The Mining Congress Journal, July 1930. Page 554.
(2) The Mining Congress Journal, July 1930. Page 555.

latter procedure being to transport the coal by rail to tidewater and thence in vessels to points along the Atlantic coast. (1)

Modern unloading facilities, consisting of the car-dumper type, by means of which the whole car is turned over and deposited on a sloping pan or hopper, and from there loaded onto the vessels with telescopic chutes, have reduced degradation a great deal. (1)

Freight charges form a considerable portion of the cost of anthracite landed in the retail coal dealers' yards. For example, the cost of Stove coal at the mines today is $ 7.25, the cost of all-rail freight, on that size to Reading, Massachusetts, is $ 3.48. So, on the face, it appears that rates are too high.

Justification of high freight rates.

Anthracite freight rates, whether they be by tidewater or all-rail are controlled by the Interstate Commerce Commission. Railroads have long been the "foot-ball" of politicians. Whenever there is any agitation for the reduction of anthracite prices the politicians immediately begin an attack on the railroads trying to force lower freight rates. If freight rates on anthracite are

(1) The Story of Anthracite. Page 567. The Hudson Coal Co.

excessive and provide the railroads with more revenue than they are entitled to, then they should be reduced. But, if the railroads are merely making a fair return on their investment, and a reduction would cause them to lose money, then they should not be reduced, because to reduce them would result in inferior service being given. The Interstate Commerce Commission has conducted many investigations of the reasonableness, or otherwise of anthracite freight rates. (1)

As a result of these investigations it was found that while a horizontal reduction of rates was not justified, certain specific destinations were entitled to reductions, and these reductions were ordered. In justifying their findings the Commission stated "Upon the record we are unable to find that all of the rates on anthracite coal now in force are excessive, unreasonable or otherwise unlawful, and in our opinion, a horizontal reduction of all of these rates, to an extent which could be reflected in an appreciable reduction in the retail selling prices of domestic sizes of anthracite, would reduce the income of several of the carriers of anthracite to an extent which would impair their credit, and consequently, their ability to perform sufficient and satisfactory transportation

(1) Interstate Commerce Commission, Docket No. 15006. Issued July 22, 1925.

service for the public. The record in "Transportation and Distribution of Anthracite Coal, supra," is persuasive of the conclusion that impairment of the ability of the respondent carriers to perform expeditious and sufficient transportation service in connection with the distribution of anthracite coal might subject consumers to hardships which would outweigh any benefits resulting to them from a reduction in rates on anthracite." (1)

An investigation by the Interstate Commerce Commission substantially reduced freight rates in 1934, as much as $ 1.00 per ton to certain specific destinations. The effect of this decision was to give fairer rates, rates that were based on the mileage covered by the coal in transit. For example, formerly there was a difference of 38¢ per ton in the freight rates between Wakefield, Massachusetts, and Reading, Massachusetts. The distance between the two towns is only two miles. Two miles is a short distance to cover by modern delivery methods, so that Reading retailers, suffering under the higher freight rate, were placed in an unfavorable competitive position. This rate was adjusted to a difference of 2 ¢ and now Reading dealers compete on an equal footing with Wakefield dealers.

(1) Interstate Commerce Commission, Docket No. 15006. Issued July 22, 1925.

Effect of high freight rates on the market.

High freight rates have been another contributing factor in the loss of market for anthracite. Together with strikes at the mines and higher production costs, with resulting higher prices, they have forced the consumer in some instances to seek a lower priced fuel for economy's sake. In other instances the consumer has sought a fuel the supply of which is assured him always. Other consumers have looked at the difference in price between anthracite and the luxury fuels, oil and gas, and finding them nearer comparable than at any time in the past have been attracted to them more than ever before.

VII. COSTS OF PRODUCING ANTHRACITE

Costs and Margins

A comparison of the mine cost per gross ton with the sales realization price can be found on page 874 of Part II of the Report of the United States Coal Commission. The figures for the last three years of operation covered by the report are as follows:

Per Gross Ton of Fresh-Mined Anthracite Produced

Year	F. O. B. Mine Cost	Sales Realization	Margin	
1919	$4.80	$5.22	$0.42	
1920	5.68	6.16	.48	
1921	5.85	6.39	.54	(1)

A study of the report shows further that the labor cost was approximately 70% of the total mine cost. Wages in the anthracite mines have increased 10% since 1921, and it is reasonable to assume that the proportion which labor cost bears to the total mine cost is as great, if not greater, than that of 1921. (1)

The margin shown must not be mistaken for the net profit, it is practically the equivalent to net operating income before the payment of interest or Federal taxes.

Figures on production costs for the industry as a whole are not available for recent years, but it is safe

(1) The Story of Anthracite.Page 350.The Hudson Coal Co.

to assume that they are higher since anthracite wages were increased by 10% in 1923. The average sales realization values was $6.19 in 1930, according to the United States Bureau of Mines report. It can readily be seen, therefore, with the increase of 10% in wages, and the decrease of 20¢ in the sales realization value, as compared with 1921, that the margin realized is less than 54¢.

Index Figures

The Monthly Labor Review, published by the United States Department of Labor, issued the following data in May 1931:

Index Numbers of Wholesale Prices of Anthracite. 1926 = 100

March 1930	February 1931	March 1931	
91.2	88.9	88.2	(1)

Anthracite wages in effect from 1926 to 1931 were kept at the same high level while the index figures for wholesale prices showed a decrease of approximately 12%.

Reductions in the price of anthracite have been brought about by intensive efforts to reduce costs by improved methods of operation and economies, but the limit has about been reached. Further reductions can come about only by the reduction of wage rates, since wages make up about 70% of the total f.o.b. mine cost.

"According to a revised report on 'Statistics of Income for 1929,' published by the United States Treasury Department, 111 companies actively engaged in the production of anthracite filed income tax returns for the year 1929. Of these, 33 reported aggregate net income of $12,236,393. and 78 companies reported deficits aggregating $9,295,976. For the industry as a whole, the net income for 1929 was $2,940,417, equivalent to slightly more than 4 cents per net ton of commercial production.

(1) The Story of Anthracite.Page 352.The Hudson Coal Co.

Approximately three-fourths of the anthracite producing companies reported deficits. (1)

(1) The Story of Anthracite. Page 352.The Hudson Coal Co.

Unprofitable Sizes of Anthracite

Buckwheat, Rice, Barley and Birdseye are the small "steam" sizes of anthracite which are necessarily produced in the making of the larger sizes. They must be sold in competition with bituminous coal which is produced and marketed at a much lower price so it is necessary to sell them below the cost of production. Pea size is likewise sold below the cost of production.

"Table 4, page 867, of Part II of the Report of the United States Coal Commission shows that the cost of producing approximately 90% of the total fresh-mined anthracite output during the year 1921 was as follows:

Average Cost per Gross Ton - Year 1921

Production Gross Tons	Labor	Supplies	General Expense	Total f.o.b. Mine cost
63,347,351	$4.05	$0.89	$0.87	$5.81

"If 40 cents per ton be added to the labor cost to reflect the 10% increase in wage rates granted in 1923, the total f.o.b. mine cost will be increased to $6.21 per ton." (1)

The sales realization values for Pea and smaller sizes is shown by the statistics published by the United States Bureau of Mines:

(1) The Story of Anthracite. Page 353. The Hudson Coal Co.

"Average Sales Realization per Gross Ton of Breaker Shipments

Year	Pea	Buckwheat No. 1	Buckwheat No.2(Rice)	Barley	Aggregate per cent of Total Breaker Shipments
1927	$5.90	$2.56	$1.78	$1.32	33.5
1928	5.00	2.75	1.85	1.38	35.6
1929	4.66	2.63	1.77	1.33	35.6
1930	4.62	2.75	1.69	1.27	36.6 " (1)

Note, please, that the sales realization for these smaller sizes falls far below the average cost of production of $6.21. These smaller sizes cost just as much to produce as the larger sizes. They contain as many heat units as the larger sizes but, because they must be sold in competition with bituminous coal for steam purposes, the price must be lower. Lately, with the advent of domestic stokers for household purposes, the smaller sizes are being used more and more. It may be with this increased demand that the sales realization price will, in time, more nearly approach the cost of production.

(1) The Story of Anthracite. Page 354.The Hudson Coal Co.

Taxation of Anthracite

In addition to the regular taxes commonly assessed against a business, the anthracite industry is taxed for all the unmined coal in the ground. These local taxes run into large figures. "Paying the highest taxes in the State of Pennsylvania and unjustly taxed," is, in substance, what Mr. Franklin Spencer Edmonds, Chairman of the Pennsylvania State Tax Commission said, speaking before the Taxation Committee of the Philadelphia Chamber of Commerce on October 6, 1926. He added, "Something must be done to relieve the (anthracite) coal producers from the excessive burden of taxation, which is not entirely due to State laws, but to a large extent by increasing local assessments on coal lands." (1)

"Mr. Edward Parker, Director of the Anthracite Bureau of Information, in an article in the July 1930 issue of the Mining Congress Journal, stated that the taxes paid by the anthracite industry had increased from $5,600,000 in 1913 to $28,000,000 in 1926 - an increase of 400%." (1)

(1) The Story of Anthracite. Page 355.The Hudson Coal Co.

VIII. CHANNELS OF TRADE

Machinery of Distribution

Anthracite follows the well-known channels of distribution common to most other products, producer to distributor, to retailer, to consumer. Some of the large producers sell their product through their own selling agencies, others market their anthracite through independent wholesale companies. Smaller companies, so-called "Independents," sell their coal through jobbers, particularly when their production is not sufficient to warrant a selling organization of their own.

"In brief, it may be stated that the wholesale distribution of anthracite is accomplished by the following three methods:

1. Sales departments or affiliated sales agencies of the producing company,
2. Wholesale agencies which dispose of the coal on a commission basis, and
3. Jobbers who buy and sell as independent dealers.

"A combination of methods 1 and 2 is used by some of the larger producing companies maintaining sales departments which dispose of the bulk of the output through established wholesale dealers." (1)

(1) The Story of Anthracite.Page 368. The Hudson Coal Co.

The Report of the Federal Trade Commission on Anthracite and Bituminous Coal, dated June 20, 1917, pages 52 and 53, contains a description of the activities of selling agencies and jobbers that fits the functions performed today.

Selling agencies of railroad coal companies.

The above report of the Federal Trade Commission says, in part, "The production of the railroad producing companies is generally distributed by their own selling organizations. There is a notable absence of any large number of middlemen such as intervene between the producer and the consumer in many lines of trade.

"The principal branch offices of the selling departments of the railroad coal companies are at New York, Boston, New Haven, Providence, Philadelphia, Baltimore, Albany, Utica, Syracuse, Rochester, Buffalo, Montreal, Cleveland, Detroit, Chicago, Milwaukee and Minneapolis. From these points sales agents canvass their designated territories. The companies sell to the retailers direct through these agents, who generally are paid on a salary basis. Thus, the retailers have the opportunity to purchase coal from the large coal producers at a price which has had added to it the expense and profit of but one selling department." (1)

(1) Report of the Federal Trade Commission on Anthracite and Bituminous Coal, dated June 20,1917. Pages 52-53.

Independent Operators and Their Marketing Methods

"Several of the independent producing companies maintain sales agencies, which sell to the retailers direct and, at times when the market is dull, or in a feverish demand, to jobbers (because the jobber is in a position to obtain more for the coal than the independent producer). The greater number of independent producing companies, however, market their coal through jobbers on a commission basis. Generally, the independent producing companies which contract with selling agencies and jobbers to market their entire production on a commission basis require that the coal be sold at the best market price while the selling agency or the jobber is to receive a stated sum per ton. The independent producer is generally not concerned as to whether his sales agent sells to retailers direct or to jobbers. He asks that he receive a return commensurate with the best market prices.

"A few independent producers do not contract with sales agencies or jobbers for the marketing of their coal, but sell outright to various jobbers and retailers. From week to week they sell to different firms, disposing of their product to the highest bidders. Generally these producers sell to jobbers for the reason that their own

selling organizations are not extensive enough to reach the retailers.

"Some of the independent producing companies sell their entire output to the railroad coal companies, f.o.b. the mine. This coal is marketed by the latter in the same manner as the railroad coal." (1)

(1) Report of the Federal Trade Commission on Anthracite and Bituminous Coal, dated June 20,1917. Page 53.

Jobbers

"The trade has applied the term 'jobber' to any firm not a coal producer which sells coal by the carload or barge load. However, concerns such as Williams and Peters,and Dickson and Eddy, which are sole selling agents of the railroad coal companies they represent, are not called jobbers. The selling agencies of the independent producers are commonly included in the term jobber. The jobber does not physically handle the coal he buys and sells. He simply finds a buyer and reconsigns to him the bill of lading for coal on the car or in the barge.

"The sources of the jobber's supply of coal are

1. Independent producing companies for which he is the sales agent;
2. Railroad coal companies which have contracts with him for the sale of certain quantities, usually of broken or of the steam sizes, or which sell him other coal that he is supposed to resell to the retailers;
3. Independent producing companies which have not selling agencies but sell to him outright; and
4. Other jobbers and sales agencies." (1)

(1) Report of the Federal Trade Commission on Anthracite and Bituminous Coal, dated June 20,1917. Page 53.

Wholesalers and Retailers

Local Wholesale trestle and dock companies.

"The wholesale trestle and dock companies differ from the jobbers in that they physically receive, store and reload the coal, selling it either in carload lots to outlying dealers or in truckload lots to local dealers."(1)

The wholesale snowbird.

The Story of Anthracite describes the wholesale 'snowbird' as one whose activities are chiefly speculative, has no regular source of supply and no regular following of customers. Whenever there is an opportunity to buy and sell coal at a profit he enters the market and leaves it when the market becomes stable again. Whenever there is a shortage of supply, because of strikes within the industry, the 'snowbird' secures the output of small operators and sells it at abnormally high prices. (2)

The old 'line companies' which produce and market the bulk of the anthracite output maintain prices at normal levels in normal times and in times of shortage.

(1) Report of the Federal Trade Commission on Anthracite and Bituminous Coal, dated June 20,1917. Pages 53 and 54.
(2) The Story of Anthracite. Page 368. The Hudson Coal Co.

The independent operators are likely to charge a premium in periods of stress and to cut prices in times of plenty.

Retailers.

The chief functions of the retailer are the storage of coal for the householder, apartment buildings, offices and small industrial plants, the delivery of the coal when needed, the extension of credit where deserved, the dissemination of information about the product and its use, when desired.

Distribution of retail tonnage.

"A survey conducted for the United States Geological Survey, published in 1923, indicated that the distribution of anthracite by retail dealers, according to the type of trade, was as follows:

Type of Trade	Per cent of Tonnage
Householders	86.4
Apartments, public buildings, etc.	9.0
Peddlers	1.8
Industries and public utilities	2.1
Other consumers	.7
	100.0 " (1)

(1)The Story of Anthracite. Page 371.The Hudson Coal Co.

IX. MERCHANDISING ANTHRACITE

History of Merchandising Product

Early efforts.

Credit for being the first to introduce anthracite to the outside world belongs to William Morris. He took a wagonload to Philadelphia in the year 1800 and attempted to sell it. This he was unable to do and he retired, discouraged. (1)

Colonel George Shoemaker took nine wagonloads of anthracite to Philadelphia in 1812 in an effort to introduce the fuel. He was able to sell two wagonloads and compelled to give away seven. The venture was hardly a pleasant one, nor a financial success, having to give away most of the coal which cost him about $28 a ton. The colonel was accused of being a swindler in that he was trying to sell black stones as coal. In fact, one customer obtained a warrant for the colonel's arrest, forcing him to avoid the officer of the law and returning to his home over a long and circuitous route. The colonel's reputation was saved by the firm of Mellon and Bishop, owners of a rolling mill, whom he induced to try his product, and who found it better for melting iron than the fuel previously used. (2)

(1) The Story of Anthracite. Page 30. The Hudson Coal Co.
(2) The Mining Congress Journal, July 1930. Page 552.

In the year 1820, the Lehigh Coal & Navigation Company shipped 365 tons to Philadelphia and while they encountered considerable difficulty in selling it, they finally succeeded and the anthracite industry was brought into being. "In 1822 White and Hazard shipped and sold 1,073 tons; the next year 5,800 tons and in 1824 9,500 tons, and the trade was established." (1)

Modern Distributional Methods.

Today modern distributional methods have been adopted by the industry. Efficient preparation of the product, rapid transportation to the dealers, ample storage space in the retail dealer's yards, effective advertising prepared by the producers, competent salesmen employed by the producers, dealer's helps given the retailers are all part of the method of today.

(1) The Mining Congress Journal, July 1930. Page 552.

Analysis of the Product

The advantages of Anthracite.

Cleanliness. Anthracite, or hard coal, is a boon to the tidy housekeeper, making no dust to be blown or tracked through the house. It burns without smoke and gives off no soot to be deposited on the carpets, woodwork, wall paper and hangings. It saves laundry bills and carpet cleaning, and the wall paper in a house will last many times as long as where some other fuels are used.

The Encyclopedia Britannica states that "Some American cities enjoy a beautifully clear atmosphere owing to the smokelessness of the fuel."

Anthracite is cleaner than other fuels because all tarry and soot producing materials have been eliminated during the formation of the coal; the remainder which is almost pure carbon burns to invisible clean gases.

"A complete absence of smoke and soot, owing to the extremely low volatile content of anthracite, has indeed become one of its best known characteristics. In order definitely to catalogue this advantage, tests were recently conducted in the Anthracite Institute Laboratory. During this investigation, the amount of soot, dirt and fly-ash passing up the chimney from 14 commonly used domestic fuels was determined by collection upon a 100-mesh screen and by subsequent actual measurement.

"Each screen was allowed to remain in the stack for a period of one hour, during which time the boiler was operated in such a manner that the same amount of water was evaporated, irrespective of the fuel used. Every effort was made to test all fuels upon a basis of equal fairness. Fuels other than anthracite were fired in accordance with accepted best practice; and for oil a popular make of combination oil burner and boiler was purchased new and adjusted immediately before the tests by the manufacturer's representatives. The data secured, therefore, present a close approximation of the relative amount of solid material that might be expected to enter the stack with various types and kinds of fuel.

"The investigation was analyzed from the following angles:

1. The character of the material as related to its ability to permanently soil or injure fabrics.

2. The density of the foreign matter. (The area covered and air pollution is inversely related to the density of the material passing up the stack).

3. The weight of the material emitted.

4. The volume of the material emitted.

"The test shows that the fuels competitive to Chestnut anthracite produced from 3 to 443 times as much

solid matter by volume. The relative densities of stack solids from the various classes of fuels also shows that anthracite fly-ash is comparatively heavy and, therefore, that the small amount produced will have a tendency to fall back into the chimney, whereas the lighter materials from competitive fuels are more likely to be carried up the stack and deposited upon surrounding properties.

"The material collected from the combustion of anthracite was, in all cases, a dry granular mixture of gray fly-ash and hard unburned coal. The ash did not contain any oily or sooty material and therefore would not, under any circumstances, stain or discolor even the chimney or roof of the home. The solid matter from other fuels was of a decided sooty, oily nature and was jet black, as contrasted with the gray-black to light gray shades of anthracite residue." (1)

Comfort. Anthracite burns steadily and continuously, for this reason anthracite frequently heats a room more uniformly and also produces more uniform temperatures from the floor to the ceiling.

Safety. Three factors are responsible for the fact that anthracite is one of the safest fuels for heating purposes. "Its non-explosive properties, combined with a relatively high ignition temperature, preclude the possibility of accidental fires and explosions. The low percentage

(1) Transactions A.I.M.E. Volume 108, page 363.

and nature of the volatile matter it contains eliminates the possibility of the production of soot, thus preventing chimney fires. The complete absence of spontaneous combustion in anthracite storage adds a final factor, thus making anthracite a truly safe fuel in all phases of its use." (1)

Economy. In addtion to the saving of laundry bills and household furnishing bills, hard coal is economical of storage room in your basement, and less fuel is used to accomplish the result you want - a good, long, steady dependable fire. There is little breakage and waste as dirt or dust, which cannot be said of other solid fuels.

Fuels are useful only for the heat which they contain. Comparisons between any two fuels should therefore be made upon a basis of the cost for a given amount of heat. This is the basis which I shall use below.

The disadvantages of Anthracite.

Ash removal. Perhaps the greatest disadvantage in burning anthracite is the removal of the ashes from the heater and from the cellar. Everyone who has done this work knows how unpleasant a task it is, and also how dirty a job it is. If one is to burn anthracite, one must expect ashes. Recent developments in stokers in which anthracite

(1) Transactions A.I.M.E. Volume 108, page 360.

is burned have done away with the necessity for removing the ashes from the heater by hand, it now being done automatically.

Inconvenience. Compared with oil and gas, a hand-fired anthracite fire is much more inconvenient to tend. More trips to the cellar, more manual labor is necessary to tend a hand-fired anthracite fire than is needed to care for an oil or gas fire. Modern stokers which burn anthracite have eliminated a great deal of the manual labor and trips to the cellar attendant upon the burning of anthracite, they feed the coal into the boiler or furnace automatically and remove the ashes in the same manner, dumping them into a dust-proof can outside the heater.

Its uses.

Domestic use. Anthracite is burned in domestic heating appliances such as stove, or house furnace of the hot air, steam or hot water type. "Anthracite has many distinct ideal characteristics that make it a superior fuel for this purpose. It is smokeless, containing a very low percentage of volatile or gaseous matter, it is clean, does not cake, emits a mild or intense heat according to draft regulation, and burns slowly to a finely divided ash which is easily shaken through the grate." (1)

(1) Practical Combustion Engineering Course for Anthracite Salesmen. Lecture 2, page 1.

Heating water. Small "bucket-a-day" stoves heat service water at a cost of only one-third to one-fifth (average one-quarter) the cost of heating the same amount of water with gas.

Steam purposes. "The primary object of any boiler plant is to supply steam in sufficient quantities for desired purposes, and the next important consideration is to produce steam with the least possible expenditure. Generally the fuel cost is the greatest item of expense. The problem then evolves into one of burning the least possible amount of coal for the generation of the greatest possible amount of steam, consistent with overall plant efficiency." (1)

"With the funds at the command of industrial consumers they can purchase the best engineering talent available, and it is inconceivable that anything but the most economical fuel would be considered and yet they are unanimous in their decision that anthracite is by far the lowest in cost for power production." (2) *

Other uses. The average coal dealer's yard does not handle refined silt, or "Anthrafine," but it is used for "the manufacture of briquettes, and in various metallurgical and chemical processes, including the recarburizing

(1) Practical Combustion Engineering Course for Anthracite Salesmen. Lecture 2, page 6.
(2) Practical Combustion Engineering Course for Anthracite Salesmen. Lecture 4, page 5.
* This statement is used with reference to a comparison of oil with anthracite.

of steel, sintering of ores, and in the manufacture of certain paints*. It is also sometimes used as fuel by the anthracite producing companies in their power plants."(1)

Research to determine new uses.

"In addition to the practical research work being conducted in the Anthracite Institute's Laboratory at Primos, Pennsylvania, research of a more academic nature has been instituted at Lehigh University, Pennsylvania State College and Yale University under the direction of Professor Homer G. Turner. This work involves the determination of the fundamental constituents of anthracite not only in developing facts which will permit a more intelligent study of methods to improve the utility of anthracite as a fuel, but also to provide the basis for the creation of entirely new uses for it outside the fuel field.

"Small-sized anthracite is being used for filtration purposes in more than one hundred water purification plants. A study is being made to determine the relative value of this filtration material as compared with sand-and-gravel mistures. The study indicates that anthracite is the more efficient agency of the two in the removal of bacteria. Investigation is being made of the

(1) The Story of Anthracite. Page 196.The Hudson Coal Co.

*Principally what is known as "mineral black."

relative efficiency of anthracite and other filtering agents to remove odors, colors and turbidity.

"Tests are being made in the Ceramics Laboratory at Pennsylvania State College of the shales found adjacent to the beds of anthracite. When pulverized, mixed with water, heat-treated and dried, these shales were found to have a greater compressive strength than concrete. A large pottery concern is also arranging to make tests of shales from the anthracite region.

"The anthracite industry, by conducting organized research both along practical and academic lines, is intelligently applying scientific methods to increase the utilization of its product. The efforts are beginning to bear fruit." (1)

(1) The Story of Anthracite.Page 362.The Hudson Coal Co.

Analysis of Market

Consuming districts.

The principal markets for anthracite are located in the New England and Atlantic States and Canada, which consume slightly more than 95% of the total production. About 81% of the total commercial production is absorbed in four states, namely, Massachusetts (8.04%), New York (35.99%), New Jersey (15.77%) and Pennsylvania (21.12%). (See Appendix R for figures relating to the geographical distribution.) (1)

Sales possibilities from the retailers' point of view.

Every home in the major consuming districts must be heated an average of 180 days and nights out of every 365 in every year. On the average, every house, to be heated properly, will burn one ton for every room heated and two tons besides. For example, an eight room house will burn approximately ten tons of fuel during a season.

Theoretically, the potential volume of solid fuel business in any community can easily be determined, but the problem of securing a fair share of that volume is a most complicated one. The retailer may discover that the buying habits and the fuel needs of his community are very different today than they were even a few years ago. In larger cities,

(1) The Story of Anthracite.Page 365. The Hudson Coal Co.

particularly, there have been many important shifts in residential population; many changes in housing conditions.

"The first essential in knowing your market is to know whether you are in step with present day fuel demands - whether there have been changes in the buying power, the comfort demands and the heating plants in the community you endeavor to serve." (1)

(1) Knowing Your Market. Page 1. The Philadelphia and Reading Coal and Iron Company.

Analysis of Competition

Anthracite vs. oil (petroleum).

I am going to quote at length from the Anthracite Institute Laboratory Bulletin, Number 19, entitled, "Anthracite vs. oil." I am doing this because it presents a much clearer, concise picture of the advantages of anthracite over oil than I could present.

"Resume of Report.

"This report compares Anthracite and fuel oil, applied to domestic heating as regards capital investment, operating costs, convenience, safety, comfort, and cleanliness.

"It is shown that equipment for burning fuel oil in the home is more expensive than present types of Anthracite burning equipment. The operating costs of oil burners are also shown to be higher than the costs for apparatus burning Pennsylvania Anthracite, based on present market prices.

"Equipment now being developed by the Anthracite Institute Laboratory has been designed for purposes of the automatic handling of all coal and ash. Unfortunately since this equipment is not yet ready for the market, it cannot be included in the present discussion.

"In the items of cleanliness, noise, even heat, safety and operating cost it is pointed out that Anthracite is superior to fuel oil.

"Description of Tests.

"The tests on oil burners were conducted in the laboratory using one of the nationally advertised and best selling oil burning boilers and later using the same burner as a conversion unit in a leading make of vertical cast iron boiler." The name of the burner used was 'Petro-Nokol'.

"This burner was installed and adjusted to a point of maximum efficiency by service representatives of the manufacturers and distributors of this unit, and the adjustment was not disturbed during the tests.

"This burner was selected for test as being representative of the very latest developments and best practice in this field. The burner, which is of the rotary atomizing type, is undoubtedly more efficient than the less expensive pot type of conversion burner.

"It must also be concluded that this report presents a comparison of Anthracite with oil when the latter is burned under the best possible conditions of equipment and adjustment. Therefore the use of inferior equipment or less fine adjustment will undoubtedly result in an even greater magnification of the advantages of Anthracite.

"Discussion of Operating Costs.

"In comparing costs of Anthracite and fuel oil for domestic heating, it must be borne in mind that a great many unfair comparisons can be made. For example, it is the practice of oil burner salesmen to quote a number of gallons of oil as the equivalent of one ton of Anthracite, which is very materially below the actual ratio. It must also be remembered that fuel oil cannot be burned without the aid of expensive equipment. Anthracite, on the other hand, can be burned without any more complicated equipment, than a grate but, in case a greater degree of convenience is desired, can be thermostatically controlled with inexpensive equipment, and can also be burned automatically and efficiently in a modern stoker.

"The curves and data in this report compare the fuel consumption of the oil burner on test with various Anthracite burning devices tested in the laboratory.

"Comparison of Fuel Consumption. Hand-Fired Anthracite vs. Conversion Oil Burner.

"A comparison of Chestnut Anthracite and a conversion oil burner using the same boiler, and identical conditions of insulation and repair is shown in the following curve: (Appendix E)

"It will be noted that at the maximum practical output of the boiler (700 sq. ft. of steam) 62% efficiency was obtained with Anthracite and 71% with oil. At this MAXIMUM possible differential 169 gallons of oil would be required to equal one net ton of Anthracite.

"However, it is an established fact that the total amount of fuel necessary during a heating season is only 32% of the maximum demand upon the boiler. A further reference to the comparative curve shows that at 32% of the maximum, or 225 square feet of steam radiation, the efficiency of oil will be only 60% and that of Anthracite 57.5%. As this rating represents a weighted average of the annual fuel requirements, it, and not the maximum efficiency determines the relative amount of fuel which will be required. Furthermore, computations on this basis indicate that 185 gallons of oil will be required to replace a net ton of anthracite.

"While the first figure of 169 gallons might be approached for short periods of time and under unusual conditions of continuous operation, the latter figure of 185 gallons is the correct comparison for this type of operation. (Conversion burner vs. hand-fired Chestnut) as applied to domestic heating.

"Various Conditions of Operation.

"Calculations similar to those described in the preceding section and based on extensive tests led to the following summarization of fuel consumption: (Appendix F)

"Comparison of Installation Costs.

"The price of this typical combination boiler and burner is quoted as $625 completely installed, tank additional. In considering the cost of the tank it must be remembered that the largest tank permitted inside a basement is of 275-gallon capacity, which is equivalent to less than two tons of Anthracite. A tank of this size in a house which had formerly burned ten tons of Anthracite would require filling at least six times per season. Outside underground tanks holding larger quantities of fuel oil are quite expensive and require considerable excavation. This highly variable item represents an additional cost differential in favor of Anthracite.

"The Fuel Oil Journal report for 1932 states that the minimum average price of an oil burner completely installed in a typical Anthracite consuming territory is $431. This minimum price, however, cannot be regarded as representative of thoroughly satisfactory equipment.

"Figures used in the following comparison are therefore typical and fair.

"For the average small home a good surface-fired Anthracite boiler can be purchased for about $100. As in the case of the oil burner combination mentioned above, piping connections are additional. This equipment would be needed if a conversion burner was being installed. A magazine boiler for burning Buckwheat coal and including thermostatic control will in comparison cost about $200. An approved Anthracite stoker can be purchased, fully installed with automatic controls and ash removal, for $450.

"All of the above prices are based on a heating load of 400 sq. ft. of steam radiation which has been chosen as an average for purposes of comparison. For larger installations approximately proportional figures will obtain. (Appendix G shows the initial cost of equipment for average home.)

"Annual Charges and Expense.

"In addition to the cost of fuel there are several other charges which must be charged against the oil burner in order to obtain a fair and proper comparison. Briefly, these are:

Gas consumption. - The gas pilot will consume 0.75 cubic feet per hour continuously. This represents an additional cost of from $3 to $4 per season.

Electrical consuption. - The burner tested consumed 95 watts per hour. Based on an estimated operating factor of 32% this would total 179 Kwh. per year of $10.75 at 6 cents per Kwh.

Depreciation charges and interest. - Depreciation is an extremely important factor which should be charged against the cost of operation. An assumption of ten years of service without major repairs is certainly liberal with an additional 6% charge to cover interest on the investment and all repairs making a total of 16%. (See Appendix H for comparison of operating costs).

"Table 4 (Appendix I) shows the total annual costs, including fixed charges, of heating a typical home for various prices of oil and of coal. These figures are based upon a home normally consuming 10 tons of Anthracite.

"Table 5 (Appendix J) shows the price at which oil must be purchased to equal the annual cost of heating with Anthracite, all charges being included. Figures are for a home normally consuming 10 tons of Anthracite. It is obvious that, as oil cannot be purchased at the price given below, Anthracite is much more economical.

"Comparative Cleanliness.

"The cleanliness of Anthracite as compared with oil has long been recognized by heating engineers and other experts who come in direct daily contact with the two fuels.

"A series of tests was conducted in the laboratory in order to illustrate this comparison of cleanliness.

"The simple expedient was used of stretching a clean square of cheesecloth across the chimney of an oil-fired boiler and a boiler fired with Chestnut Anthracite. These squares were allowed to remain for one hour, after which they were removed and inspected.

"The extremely small amount of dust which was obtained in the Anthracite stack was completely free from any sooty or greasy components. On the other hand, the dirt obtained from the oil burner was an oily, sooty substance which not only soiled the clothing but which could not be removed by any ordinary means of washing. In some instances large particles of pure carbon from one-quarter to one-half an inch in diameter were found clinging to the cloth.

"As these test represent only one hour of operation, the comparative effect upon furnishings, draperies, wash on the lines, and even shrubbery in a neighborhood can easily be imagined.

"Every effort was made to secure these tests under conditions which would be fair to the oil burner. The preparations included having the manufacturer send a representative to the laboratory to adjust and check the

installation of the burner, immediately preceding the tests. The burner was also of a make recognized as being among the best.

"Moreover, this comparison was based upon results obtained with an oil burner that had just been cleaned and was therefore in its best possible condition of efficiency.

"The tendency for an oil burner to become clogged with soot and thus to lose its adjustment is so pronounced that it is common practice in industrial and marine work to change the entire burner tip every few hours. As this is rarely, if ever, done in residential practice, even larger quantities of soot and dirt may be expected than these tests would indicate.

"Instances are not unknown in which accumulations of soot and dirt in the boiler have been distributed throughout the entire house to the extent that required the redecorating of the building, even including thoroughly cleaning the rooms, repapering, and repainting, not to mention damage to upholstered furniture and draperies. While such occurrences are of course not common, they are by no means rare and are rendered even more serious by reason of the fact that very few fire insurance policies cover losses due to such causes.

"The Cause of Noise in Oil Burners.

"All machinery may be expected to operate with some slight amount of noise. However, this can be reduced to a minimum by proper design and lubrication. Automatic Anthracite stokers are, for example, extremely quiet and one of an approved design would not be heard in the living quarters of the home. Oil burners would probably be noiseless also if it were not for the noise of the flame itself, caused by millions of minute explosions as each particle of oil ignites with oxygen to burn. This noise factor is frequently of an extremely objectionable type, and being inside of the furnace cannot be damped or readily suppressed.

"While it is undoubtedly true that there is a great deal of variation in the amount of noise produced by burners of different makes, it is significant that oil burner interests frequently advise prospective customers to consider a burner from the angle of the amount of noise which it produces.

"Comparative Comfort.

"One of the most serious limitations of the use of oil for domestic heating is the inability of designers to produce an oil burner which can be modulated, that is, one in which the fuel feed and heat production can be adjusted to suit the existing weather conditions.

"Because of this limitation it is necessary to operate an oil burner at a fixed rate, depending upon it shutting off entirely if producing any less heat that its maximum capacity. Since the maximum is demanded during less than one-third of the time, it is apparent that for two-thirds of the heating season the burner is supplying heat intermittently with corresponding fluctuations in the room temperature. As no thermostat can be designed to respond instantaneously, this sometimes results in serious discomfort and is always inferior to the steady, even heat of a properly controlled Anthracite fire.

"The president of a leading oil burner company recently estimated that this ignition cycle may be repeated as often as 12 to 24 times per day or 2500 to 5000 times during the heating season. Each of these cycles implies a variation in room temperature in addition to placing considerable strain on ignition equipment.

"As contrasted with the intermittent heat of such a nature, the accompanying chart (Appendix K) is typical of the even burning characteristics of Anthracite.

"This accompanying chart indicates the results of operating a popular type of Anthracite burner as installed in a pipeless furnace. The furnace was operated from 4 P.M.

on November 26th to 8 A.M. on November 28th. During this period the stoker was set at a point which experience had indicated would be satisfactory for the maintenance of the proper temperature within the laboratory. (Thermostat in this case was not used.) The chart indicates an outdoor temperature decline of 22 degrees during this period, whereas the drop in room temperature was only 6 degrees. If a thermostat had been used the temperature in the room would undoubtedly have been constant. (It was, however, desirable to show that with Anthracite a thermostat is not absolutely essential to comfort and even heat.)

"Coinciding with the beginning of this practical trial, other boilers under fire in the same room were shut down. At least a part of the 6 degree drop in the indoor temperature curve, therefore, can be attributed to the cooling off of the other boilers. As the laboratory was closed and locked during this entire period, no manual attention of any kind was received by either stoker or furnace.

"Comparative Safety.

"Statements and pamphlets of both the underwriters and insurance companies frequently call attention to the fact that with the increased use of oil and gas as a fuel for heating and power boilers, there has been a corresponding increase in explosions in furnaces and flues caused by the accidental ignition of combustible gases collected in these places.

"Such damage to boilers, caused not by steam pressure, but by a force outside of the boiler proper, is not ordinarily covered by the steam boiler insurance policies issued by any company. A recent court decision, involving an accident at Lincoln, Nebraska, indicates that ordinary fire insurance is equally ineffective in covering oil burner blasts, unless an actual fire ensues. As has been mentioned, smoke and soot can be emitted by such an explosion, without actual fire, but with damage which may be equally severe. The recommendation of the necessity for safeguards by such authorities should be positive proof of the potential danger when dealing with an inflammable fuel.

"This danger may be divided into two parts, first the danger from the storage of the material itself which may be readily ignited by any number of accidental causes, and second, the even greater danger of explosions, due to the accidental ignition of the oil in the furnace at a time when there is an excessive accumulation of gas.

"Both of these causes are likely to result in damage to the equipment, fire or equally as serious damage due to the spreading of greasy soot throughout the home.

"As contrasted with this property, Anthracite contains a nigligible percentage of volatile matter and

cannot, under any conditions of adjustment, produce either soot or smoke. Furthermore, its ignition temperature is so high as to preclude any danger due to spontaneous combustion or accidental ignition.

"Disadvantages of Intermittent Ignition.

"In addition to the disadvantages which have already been enumerated, intermittent ignition also presents the following difficulties:

The alternate expansion and contraction of the metal parts in both the burner and the boiler. In warm air furnaces this is frequently such a pronounced disadvantage that some means of absorbing the heat during the "on position," and giving it up during the "off position" must be employed to protect the furnace. While the cause is almost as severe in the case of warm air furnaces and steam heaters, the jacketed furnace allows the condition to pass with less visible evidence.

Frequent starts and short running periods is a further contribution to the inefficient operation of the average burner. The intermittent operation of the burner results in a waste of heat due to excessive stack temperatures in the "on position," and rapid cooling during the "off position." Efficiency is further lowered due to incomplete combustion when starting with a cold boiler.

The excessive number of operating cycles with the consequent emission of intermittent heat will cause overrunning and subsequent wide fluctuations in room temperature.

The available draft in any heating unit depends upon the heat in the stack; thus, after an oil burner has been operated for a considerable length of time and is suddenly turned on, gases are frequently generated faster than they can be removed by the normal stack action. This is very likely to result in the leakage of gas and dirt into the cellar, and in extreme cases where the ignition has been delayed until the stack is filled with combustible mixture, sudden ignition may cause an expansion of gases with sufficient rapidity to create an explosion."

Thus, it can be seen that oil is a luxury fuel that does not guarantee all the benefits one expects from a luxury. Greater comfort is not derived from it, neither is cleanliness assured. It is a boon to the infirm and lazy who do not want the work of carrying out a few ashes from the cellar, and it does save trips to the cellar.

Oil has advanced rapidly as a competitor to anthracite in the last few years due chiefly to better merchandising on the part of oil burner companies which have

advertised extensively, and well-trained salesmen whom they have placed on the road to introduce their product.

Anthracite vs. coke.

By-product coke has come into prominence as a competitor to anthracite during the last four or five years, due chiefly to a superior merchandising program. Coke and oil are perhaps the two most formidable competitors for the market anthracite has so long held.

The New England Coke Company has stated the following as some of the advantages of coke. After each item I am giving my personal observations.

1. It will last as long, ton for ton, as any other solid fuel.

Customers of ours give varying reports on the length of time a ton of coke will last, but the consensus seems to indicate that the consumers as a whole do not agree with this statement. My personal experience has shown me that I will burn from one to two tons more coke in a heating season than I formerly burned with anthracite.

2. It is cleaner and lighter to handle.

Emphatically, "NO", would our customers shout in reference to the claim of greater cleanliness. Coke dust seeps through the floors and permeates the whole house

when the coke is being put into the bin. One customer complained of this coke dust so we took elaborate precautions in delivering the next load, such as wetting down his bin floor, wetting the coke, etc., but he complained bitterly after the coke was delivered. A coating of dust covered all his furniture, rugs, bathtub, and draperies. Of course, in a house having tight floors this is not so likely to happen but nevertheless, I am prepared to dispute their claim of greater cleanliness.

3. Adapted for use in any type heater that burns a solid fuel.

This is no advantage over anthracite, because it is also true of anthracite.

4. It requires no more than normal attention.

Once again, our customers are inclined to dispute the claim. At least three or four trips to the cellar are needed to give it the attention it needs, claim the consumers. Anthracite is heavier than coke; a given volume of furnace will hold more pounds of anthracite than coke. Since both fuels contain about the same number of heat units per pound, more heat units of anthracite than of coke can be placed in the furnace at one time so that fire lasts nearly twice as long.

5. It will not clinker under domestic conditions.

Perhaps it will not clinker if conditions are ideal, if the proper size is used, if the ash pit is kept clean, if the proper kind of a fire is kept, neither too much nor too little ash on the grate. But, where is their a consumer that takes care of his fire according to best instructions? It is a fact that coke will clinker, and although the fault may be with the manner of running the fire and not with the fuel, nevertheless it will clinker. Perhaps the greatest number of complaints we hear about coke refer to the tendency of the fuel to clinker. Anthracite fires seldom clinker regardless of the nature of the fire.

6. It maintains a steady and even heat.

I believe it maintains a steady and even heat if sufficient attention is paid to the fire.

7. High in heat content, low in ash content.

It contains about the same number of heat units per pound as anthracite, and approximately the same amount of ash per ton.

8. There is a saving of several dollars a year.

If one burns more coke than anthracite there is no saving at today's prices of coke. There is a difference of only $1.10 in favor of Stove coke over Stove coal. If a customer burns twelve tons of coke, compared with ten tons of anthracite, it is cheaper for him to burn anthra-

cite. Twelve tons of coke at $13.00 per ton equals $156.00, whereas ten tons of anthracite at $14.10 costs $141.00.

Laboratory tests. The Anthracite Institute has made tests using by-product coke and anthracite and compared the two fuels in a report from which I am going to quote at length again; it is Laboratory Bulletin No. 17, entitled "Anthracite vs. By-Product Coke." It follows:

"Description of Report and Fuels Tested.

"This report is a non-technical resume of Anthracite Institute Laboratory Report No. 2020. All descriptions of testing methods and discussions of results have been omitted for purposes of simplification.

"The Anthracite and Coke tested as a basis for this report were purchased on the open market and from retail fuel dealers in the vicinity of the Laboratory. No intimation was given of the purpose for which they were intended, nor was any attempt made to secure coal other than that which would be sold to domestic consumers in the same vicinity.

"Comparative analyses, as reported by Smith-Rudy and Company, analytical chemists of Philadelphia, were of particular interest in that an average of six samples showed Anthracite to have a heat value approximately 530

B.T.U.'s in excess of coke. It was also shown that the weight of Anthracite averaged 55 pounds per cubic foot, whereas Coke weighed only 28¼ pounds for an equal volume.

"The fusion point of Anthracite was also considerably above that of Coke.

"Relative Density and Bulk.

"Coke requires twice the storage and furnace space as Anthracite. One of the principal reasons for the less frequent firing attention required by Anthracite is the increased density as compared with coke. This physical disadvantage permits a greater quantity of fuel, having a considerably greater amount of potential heat, to be placed in the heater at a single charging.

"As was previously stated, the Anthracite tested weighed fifty-five pounds per cubic foot and coke 28¼ pounds, a density ratio of 1.95 to 1. As the heat value ratio of Anthracite and coke was as 1.05 to 1, exactly twice as much furnace volume would have to be provided for a given potential heat value with coke as with Anthracite, in order to avoid an increase in the required amount of manual attention.

"Similarly, retail storage space, truck facilities and cellar storage capacities must all be increased in the ratio of two to one to allow a substitution of coke for Anthracite.

"Output vs. Draft.

"Contrary to popular belief, coke produces less heat with a given draft.

"The extremely rapid burning characteristic of coke tends to liberate greater quantities of heat than can be absorbed by a boiler of normal design. As a result, the excessive heat escaping up the stack with correspondingly increased temperatures creates abnormally high drafts. It has been demonstrated, however, that the output of a coke-fired heater with any given draft is actually less than that of the same boiler (and draft) when fired with Anthracite.

"As increased stack temperatures are wasteful of fuel, the ability of Anthracite to generate heat with less draft than coke is a decided advantage in favor of hard coal. (Appendix L)

"Relative Efficiency.

"Anthracite is more efficient at all rates of firing comparable to mid-season requirements. It will be noted that both fuels attained approximately the same maximum efficiency. However, in the coke-fired boiler, the maximum occurred at a low rate of firing which would only be duplicated in the Spring and Fall when relatively small quantities of fuel were being burned.

"At all points over 70% of the heater capacity, Anthracite was considerably above coke. As the latter is typical of winter conditions when the greater part of the fuel is used, a fuel saving in favor Anthracite is clearly indicated." (Appendix M) Also see Appendix T.

"General Combustion Characteristics.

"Anthracite is shown to be more even burning and more uniform in heat output. The curve shown on the right gives a graphic picture (Appendix N) of the general combustion characteristics of Anthracite and coke as burned in a domestic space heater.

"The superiority of Anthracite from a standpoint of the production of even heat over a long period of time is clearly illustrated as compared with the flash type of combustion which was characteristic of coke during these tests.

"Relative Firing Interval.

"Coke required twice as much manual attention as Anthracite. The actual firing interval necessary with both Anthracite and coke is dependent upon the rate of output and upon the amount of fuel fired at each period. The relative amount of attention required, however, remains decidedly in favor of Anthracite under all conditions of operation, as is illustrated in the following table: (Appendix O)

"In all of the tests, firing attention was given only when the output of the boiler dropped to 75% of normal. This condition simulates actual practice where firing would be dictated by necessity.

"Relative Banking Periods.

"Anthracite can be banked twice as long as coke. The following curve (Appendix P) shows the relative banking periods of one cubic foot of Anthracite and coke at .003 inches of draft:

"It is, of course, true that larger quantities of fuel and further decreased drafts will increase the number of hours that the fuels will bank. It will not, however, destroy the banking relation between the two fuels. Anthracite will therefore bank approximately twice as long as coke under comparable conditions.

"Furthermore, the light body of coke increases its tendency to become prematurely extinguished at all low rates of banking and combustion.

"Time Required for Acceleration.

"With identical drafts, Anthracite required only three minutes more to reach maximum output from a cold start. The acceleration period required for Anthracite and coke to reach a normal rate of boiler output with one-tenth inch of draft was found to be 20 and 17 minutes respectively.

"While this fact indicates a slight advantage for coke, three minutes is by no means a serious item, nor does it in any way offset the many other advantages which have been shown to favor anthracite as compared with coke.

"Absorption of Moisture.

"Anthracite absorbed 2¼% - coke 8% of moisture. The large amount of water absorbed and held in the pores of coke is a well-known disadvantage.

"Tests in the Laboratory indicated that coke which has been wet will retain three and a half times as much moisture even after having been thoroughly drained to remove free water.

"As an indication of the permanent character of the entrainment of moisture, the moist coke sample (100 pounds) lost only nine-tenth pounds or 11% of its moisture after having been allowed to stand overnight in a warm, dry room. (Appendix Q)

Anthracite vs. Bituminous Coal.

In the chief consuming districts of anthracite, bituminous coal competes with anthracite chiefly in the production of power in the commercial and manufacturing field. Bituminous, or soft coal, always has been and probably always will be, used to some extent in domestic

heating. In the west, anthracite is hardly known for any type of heating, soft coal being used almost entirely. It is the competition in the established anthracite consuming sections of the country that I am considering. In those sections dealers are catering to the demand for a cheaper fuel by screening their soft coal.

Smoke and dirt are the chief disadvantages of this competitor of anthracite, and these two disadvantages are difficult to overcome. The tidy housewife wants none of the dirt accompanying the burning of bituminous coal. This dirt is due, not only to the smoke and soot, but also to the tracking of coal dust and fine particles of the fuel upstairs from the cellar.

Smoke is not only unpleasant but unhealthy. It is costly waste. The black clouds that pour out of soft coal furnaces are part of the coal itself -- escaping unburned. When we burn soft coal, it costs money in other ways. The smoke and soot soil our homes inside and out. Higher cleaning bills are a portion of the cost of burning such coal.

In actual laboratory tests it was found that oil, coke and bituminous coal produced from 3 to 443 times (by volume) as much soot as anthracite. (1)

(1) Transactions, A.I.M.E. Volume 108, page 364.

"There is no doubt smoke is one of the greatest nuisances of modern civilization. It is a well-known fact that it has a deleterious effect on public health and welfare and millions of dollars worth of property is destroyed annually by its presence." (1)

"Property damage due to smoke runs into millions of dollars a year. In Rochester, New York, the National Conference Board on Sanitation found that one ton of soot falls in each square mile every 24 hours, while in certain sections of the city, the amount is as high as three tons a day. Each year, smoke costs us about seventeen dollars for every person in the United States!" (2)

"Anthracite is denser, harder, and cleaner than bituminous. It does not emit smoke under any conditions; bituminous always burns with a smoky flame except in furnaces of special design and under proper conditions. Bituminous usually clinkers; anthracite seldom does." (3)

It is an indisputable fact that many plants used for the purpose of producing power in the commercial and manufacturing field are now operating with anthracite and are obtaining far superior results from the smaller so-called steam sizes than obtained with any other fuel.

(1) Practical Combustion Engineering Course for Anthracite Salesmen. Lecture 2, page 4.
(2) Buried Sunshine. Page 17. The Philadelphia and Reading Coal and Iron Company.
(3) A Catechism of Anthracite. Page 14. Anthracite Institute Laboratory.

"In textile mills, silk mills and other similar industries, freedom from visible smoke and its attendant evils is greatly to be desired and even more important than the reduced cost of operation and yet with anthracite both benefits are easily obtained." (1)

Anthracite vs. Gas. (Manufactured Gas)

If gas could be sold as cheaply as anthracite, there is no doubt that it would be a powerful competitor for the market of anthracite. At today's prices, however, it cannot successfully wage a fight for the business, and yet, it has made great inroads in the sales of Chestnut anthracite which was formerly the favorite fuel for kitchen ranges. Gas kitchens are rapidly becoming popular.

Convenience is the big selling point of gas as a fuel. Merely by turning a jet any desired amount of heat may be obtained, or in the case of a furnace using gas as a fuel one need not even turn a jet, it being thermostatically controlled.

Cleanliness is another asset which gas heating possesses, there being no smoke nor soot connected with gas heating, nor are there any ashes to be removed.

Comfort such as is acquired by the use of anthracite is not possible with gas as the means of heat. "Both oil and gas are commonly used in "intermittent" types of

(1) Practical Combustion Engineering Course for Anthracite Salesmen. Lecture 2, page 5.

burners in which the heat is alternately "on" and then "off". Anthracite on the other hand burns steadily and continuously. For this reason, Anthracite frequently heats a room more uniformly and also produces more uniform temperatures from the floor to the ceiling. In substantiation a recent official publication of the gas industry(1) recently stated that with gas there is frequently a 12 degree difference between the temperature at the floor and at the breathing line." (2)

Economy favors the use of anthracite in preference to gas as a fuel. As I have said before, fuels are useful only for the heat which they contain. Comparisons between any two fuels should therefore be made upon a basis of the cost for a given amount of heat.

"A ton of anthracite contains approximately 26 million heat units; a cubic foot of manufactured gas contains 525 to 540.

"At $13.00 per ton, for example, a million heat units of anthracite cost $.50 and at $.75 per thousand cubic feet, a million heat units of manufactured gas costs $1.40."(3)

(1) Either the 1932 or the 1933 report of the House Heating Committee of the American Gas Association.
(2) A Catechism of Anthracite. Page 13. Anthracite Institute Laboratory.
(3) A Catechism of Anthracite. Page 14. Anthracite Institute Laboratory.

It takes, therefore, approximately 49,000 cubic feet of artificial gas to produce as much heat as a ton of coal, and at $.75 per thousand cubic feet that would amount to $36.75. It can readily be seen, therefore, that manufactured gas as a competitor of anthracite must suffer a great decrease in cost in order to be successful.

Anthracite vs. foreign coals.

Coal from Russia, the United Kingdom and Germany has made serious inroads into the market for anthracite, particularly in Canada. Comparisons with American anthracite show that the coal from these countries is really an anthracite itself and possesses most of the characteristics of American anthracite. It is marketed under the names of "Cleercoal","Beacon", etc.

Most foreign coals are freer-burning than the American product and are not particularly well suited for conditions where the chimney draft is good and a long,steady heat is desired. This is an advantage, however, when a quick, hot fire is desired.

The ash content is very low in most foreign anthracite. They advertise "less than a barrel of ashes to the ton." This is a decided advantage that they can claim for their fuel.

This type of fuel suffers a great deal of degradation in handling, it being far more friable than our own fuel. This feature of the coal does not appeal to the retail fuel dealer, nor to the ultimate consumer who objects to paying good money for that which he calls "screenings."

The chief advantage that our country's hard coal hods over foreign hard coal is its economy. Being a freer burning coal, foreign anthracite burns more rapidly and thus occasions the use of more fuel. The heat unit content of the two coals is substantially the same, the price of foreign anthracite is approximately $1.00 more per ton around Boston and relatively greater at inland communities according to the freight rates to those sections.

Anthracite vs. petroleum coke.

Petroleum coke, the ashless solid fuel, made a splurge in New England markets about a year ago and then apparently died out, due, the jobbers said, to a shortage of the fuel. Today, although a little is still sold, it is not a serious competitor at least for the Eastern market.

Producers of this by-product advertise it as "the hottest solid fuel known" and as having "a shovelful of ashes to the ton." One wit inquired if it meant a steam-shovelful. But it is true that it is the lowest in ash content of any of the solid fuels. It is possible also

that it is the hottest solid fuel known. But, these are not always advantages for a fuel.

Petroleum coke has all the disadvantages of other by-product cokes in the increased amount of firing attention which it necessitates, the shorter banking periods and all the rest which I am not going to enumerate again.

"As compared with petroleum coke and other ashless solid fuels, an additional advantage for anthracite was found to be that it was not nearly so destructive to the grates of the furnace. As an example of the destructive action of petroleum coke, a Pennsylvania realtor has included the following clause in all of the leases of his company: 'It is agreed that the lessor is not responsible for grates in the furnace if the lessee burns petroleum coke therein."(1)

Anthracite vs. briquettes and ovoids.

To meet the demand for a cheaper fuel these prepared coals were introduced to the market. Since these fuels are not important competitors of anthracite, I shall merely point out one or two of the features of the fuel.

The chief advantages that anthracite holds over these fuels are the lack of tarry soot, lack of dirt and lack of smoke. The tarry soot clings to the heating surfaces of the heater, reducing the heating efficiency.

(1) Transactions, A.I.M.E. Volume 108. Page 368.

Discussion of Merchandising Activities

Merchandising by competitors.

During the anthracite strike of 1925, anthracite competition took tremendous strides forward. New methods of merchandising were adopted, including widespread newspaper and magazine advertising, house-to-house canvassing, selling by telephone, prompt service at all times (oil companies promise 24 hour service), contracts protecting the consumer against price advances. To illustrate this development of merchandising in the fuel industry, I am going to consider merchandising as applied to the coke industry. A contemplation of the selling activities of this industry gives a fair indication of the activities of other competitors, such as oil and gas.

Coke merchandising.

Coke companies have done a fine job of merchandising their product in the last four or five years, particularly in New England. This fuel, a by-product in the manufacture of gas, was, at one time, practically given away to anyone who would cart it away,and even then customers were few. Consumers did not understand how to burn coke and few appreciated that it could be burned successfully in domestic heaters. Then along came new men in the gas-making industry. They had foresight enough to visualize

a huge market for coke provided the public could be educated to burn it properly. They installed research laboratories, training schools for salesmen and service men, launched an intensive advertising campaign, and sent their salesmen on the road canvassing house-to-house.

These salesmen and this advertising chased the old bugaboo, the fear of clinkers, out of the minds of the consumers. The salesmen induced the customer to try one or two tons and then followed up his sale by calling around to the house again and demonstrating the correct use of the fuel. Then he did not retire from the field, but followed up again sometime later on to see if the consumer was having success.

An intensive newspaper advertising campaign was started calling attention to the benefits to be derived from burning coke and they were persistent in their advertising, having continued it up to the present day. The radio and billboards were also used as mediums for putting across their product.

Probably their greatest stroke of merchandising genius was their "Price Protection Contract," a new feature in the selling of fuel. This contract guaranteed the price of the fuel for the coming season, provided two tons were delivered to the customer's bin during the summer months. This contract was not binding on the customer in regard to

the type of fuel he must burn after the first two tons were burned. So confident was the coke company of the success of its fuel, that they sold it on a "money-back guarantee."

Dealers were given help, too. Schools for the training of retail salesmen for the dealer were opened at the coke plant. Service men are "on call" at any time to instruct a dealer's customer in the proper method of tending his fire. Co-operative advertising is favored, the dealer paying part of the cost and the coke company a portion. Advertising material, in the form of circulars, cuts, etc., are furnished the dealer free of charge. (1)

Merchandising of Anthracite.

Since the loss of market in 1925 to competitors, the anthracite industry has made desperate struggles to regain it. Formerly all the advertising they did consisted of a card in the local newspaper, all the selling consisted of answering the telephone or taking orders over the counter. With the advent of serious competition anthracite producers awoke to the need of better methods of marketing their product. They began to more efficiently prepare their coal, they hired advertising experts and marketing experts, efficient salesmen were trained and gradually they are beginning to recover the lost market.

(1) Personal experience.

The experts on marketing and sales prepared books for distribution to the retail dealers, teaching them to better market their product. Books, such as the following, were issued: "Knowing Your Market" - "Developing a Sales Service Department" - "Selling Solid Fuels by Telephone" -"Home to Home Selling" - "Special Market Analysis and Sales Survey" - "25 Good Collection Ideas and Letters" - "Analyzing, Controlling and Collecting Accounts Receivable" - "Customer Control."

Certain of the larger producers trained retail salesmen to sell their coal, giving them points on the ways of obtaining proper combustion.

"Then there is the Anthracite Institute, the trade association of the anthracite mining industry of Northeastern Pennsylvania, which was organized in 1925. Through several permanent bureaus or committees, it maintains contact with retail coal dealers, undertakes research, directs sales promotion, service and advertising. It has established standards of sizing and purity of preparation. The Institute maintains a force of inspectors who examine and report upon breaker screens and the market product of individual members to see that its established standards are complied with." (1)

(1)The Story of Anthracite. Page 380. The Hudson Coal Co.

X. EFFECT OF COMPETITION

Effect on Anthracite Production Figures

The effect of competition on the entire anthracite industry is well represented by its effect on the production figures.

We have already noted the decrease in production figures since 1927 (see Appendix D) which is due to competition. For example, "During 1930, the natural market for Pennsylvania anthracite was adversely affected to the extent of 1,888,736 tons by the importation of 1,287,534 tons of foreign anthracite by Canada, and 601,202 tons by New York and the New England States. This is equivalent to approximately 3% of the total commercial production of Pennsylvania anthracite, which, in itself, is not sufficient seriously to threaten the existence of the Pennsylvania anthracite trade." (1)

The effect of all the competition is enough to cause serious alarm, however, among the anthracite producers. For example, consider the estimates of the Anthracite Institute which has been making a study of the competition to anthracite from oil, coke and gas.

(1) The Story of Anthracite. Page 378. The Hudson Coal Co.

"These figures are, of course, almost impossible to ascertain accurately, but our best estimates lead to an annual loss to oil of around 10,500,000 tons in the United States and Canada, including about 1,250,000 tons in New England due to the widespread use of range oil burners.

"In the case of coke, our annual loss approximates 9,500,000 tons per annum, as compared, like oil, to the peak year 1923.

"In the case of gas, most of the kitchen business had been lost prior to 1923 and subsequent competition has centered largely in water heaters and domestic installations, fired with both natural and manufactured gas. Probably about 1,500,000 per annum represents our loss in this market." (1)

Basic data is not available so it is impossible to be more specific.

(1) Letter from Mr. Norman F. Patton, an official of the Anthracite Institute, directed to the author, dated April 11, 1935.

XI. SUMMARY

Formed millions of years ago by Mother Nature, anthracite came into popular use scarcely more than a century ago. It developed into one of the leading industries of the nineteenth century and exerted a powerful influence on the Industrial Revolution.

Modern machinery and improved methods have advanced the science of mining and preparation of anthracite a long way toward perfection. Labor troubles at the mines have driven many consumers to competing fuels where the source of supply is assured. Railroad transportation has become the dominant means of carrying the fuel to the market.

In computing the costs of producing anthracite, great attention must be paid to the item of labor which forms the largest part of the cost.

The chief appeal of coke and bituminous coal in competition with anthracite is their lower price. Oil and gas also compete with anthracite for domestic heating purposes, but careful studies have shown that in the great majority of cases the cost of these fuels is considerably higher than anthracite. Oil and gas are luxury fuels and their chief advantage is convenience. Anthracite is meeting this competition with automatic anthracite burning appliances and ash removal systems which have the advantages of conven-

ience, safety, cleanliness and economy. Explosion insurance is not required where anthracite is used. In sharp contrast to the high volatile competitive fuels its use is not harmful to health.

APPENDIX A

Anthracite

	Imports		Exports	
	Gross Tons	Net Tons	Gross Tons	Net Tons
1900	118	132	1,662,286	1,861,760
1901	286	320	1,993,307	2,232,504
1902	170,211	190,636	907,977	1,016,934
1903	175,747	196,837	2,008,857	2,249,920
1904	72,529	81,232	2,228,392	2,495,799
1905	34,241	38,350	2,229,983	2,497,581
1906	32,354	36,236	2,216,969	2,483,005
1907	9,897	11,085	2,698,072	3,021,841
1908	16,484	18,462	2,752,358	3,082,641
1909	2,191	2,574	2,842,714	3,183,840
1910	8,196	9,180	3,021,627	3,384,222
1911	2,463	2,759	3,553,999	3,980,479
1912	1,670	1,870	3,688,789	4,131,444
1913	896	1,004	4,154,386	4,652,912
1914	15,800	17,696	3,830,244	4,289,873
1915	727	814	3,540,406	3,965,255
1916	World War		4,165,652	4,665,530
1917	"	"	5,363,666	6,007,306
1918	"	"	4,435,543	4,967,808
1919	73,945	82,818	4,443,391	4,976,598
1920	28,346	31748	4,824,776	5,403,749
1921	7,941	8,894	4,176,221	4,677,368
1922	208,507	233,528	2,365,587	2,649,457
1923	268,179	300,360	4,544,766	5,090,138
1924	105,313	117,951	3,587,308	4,017,785
1925	341,870	382,894	2,838,398	3,179,006
1926	726,746	813,956	3,597,931	4,029,683
1927	106,277	119,030	2,969,203	3,325,507
1928	343,488	384,707	2,978,814	3,336,272
1929	434,975	487,172	3,041,401	3,406,369
1930	602,511	674,812	2,278,267	2,551,659
1931	569,599	637,951	1,587,775	1,778,308
1932	542,051	607,097	1,163,709	1,303,355
1933	407,367	456,251	923,714	1,034,560

A Catechism of Anthracite. Page.24. Anthracite Institute.

APPENDIX B

Details of Imports for the Twelve Months Ended December 31, 1933, by Import Districts.

Import District	Net Tons	%
Maine & New Hampshire	18,864	4.1
Massachusetts	336,829	73.9
Rhode Island	79,905	17.5
Connecticut	7,392	1.6
New York	13,247	2.9
Washington	3	0.0
Oregon	7	0.0
San Francisco	4	0.0
Total	456,251	100.0

Source	Net Tons	%
United Kingdom	200,290	43.9
Russia	229,150	50.2
Germany & Belgium	26,801	5.9
Indo-China	8	0.0
Netherlands	2	0.0
Total	456,251	100.0

Mac's Directory of Anthracite. Page 17. Coal Information Bureau.

APPENDIX C

Details of the Value of Anthracite Produced in the Present Century

Year	Total Production Net Tons	Value	Average Value per net ton
1901	67,471,667	$112,504,020	$1.67
1902	41,373,595	76,173,586	1.84
1903	74,607,068	152,036,448	2.04
1904	73,156,709	138,974,020	1.90
1905	77,659,850	141,879,000	1.83
1906	71,282,411	131,917,694	1.85
1907	85,604,312	163,584,056	1.91
1908	83,268,754	158,178,849	1.90
1909	81,070,359	149,415,847	1.84
1910	84,485,236	160,275,302	1.90
1911	90,464,067	174,952,415	1.93
1912	84,361,598	177,622,626	2.11
1913	91,524,922	195,181,127	2.13
1914	90,821,507	188,181,399	2.07
1915	88,995,061	184,653,498	2.07
1916	87,578,493	202,009,561	2.31
1917	99,611,811	283,650,723	2.85
1918	98,826,084	336,480,347	3.40
1919	88,092,201	364,926,950	4.14
1920	89,598,249	434,252,198	4.85
1921	90,473,451	452,304,903	5.00
1922	54,683,022	273,700,125	5.01
1923	93,339,009	506,786,768	5.43
1924	87,926,862	477,230,852	5.43
1925	61,817,149	327,664,512	5.30
1926	84,437,452	474,164,000	5.62
1927	80,095,564	420,941,726	5.26
1928	75,348,069	393,638,000	5.22
1929	73,828,195	385,643,000	5.22
1930	69,384,837	354,574,000	5.11
1931	59,645,652	296,355,000	4.97
1932	49,855,221	222,375,000	4.46
1933	49,541,344	206,718,000	4.17

A Catechism of Anthracite. Page 19. Anthracite Institute.

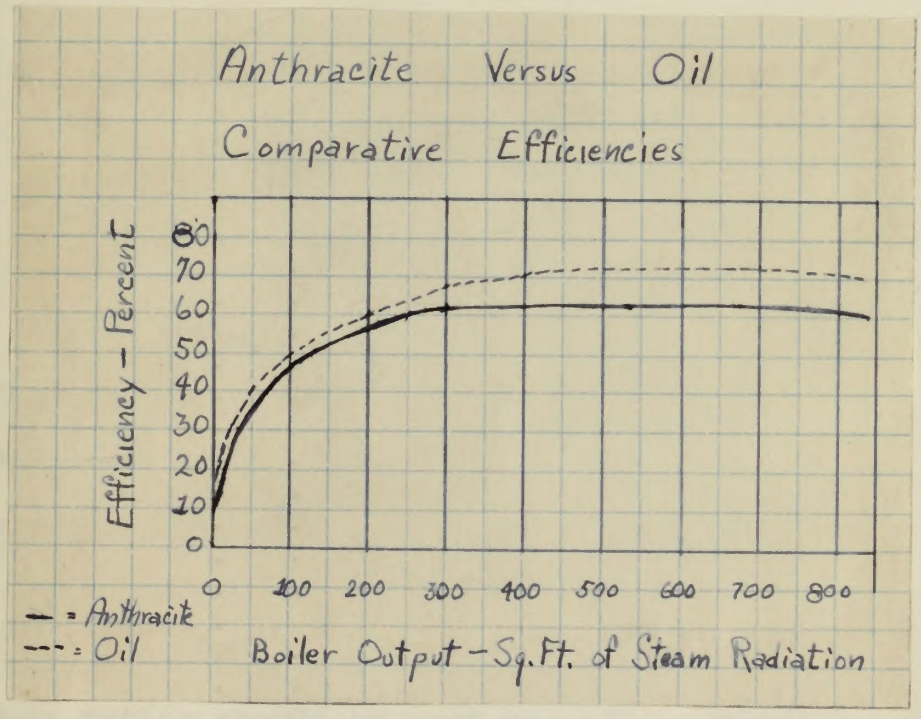
APPENDIX D

Detail of anthracite shipments - 1907 to 1933

Year	No. Tons
1907	67,109,393
1908	64,665,014
1909	61,969,885
1910	64,905,786
1911	69,833,801
1912	64,667,249
1913	70,758,312
1914	69,947,357
1915	68,179,474
1916	67,060,356
1917	77,062,787
1918	76,307,687
1919	67,599,720
1920	68,189,705
1921	69,316,877
1922	40,863,359
1923	73,146,809
1924	68,813,546
1925	47,902,816
1926	67,042,989
1927	62,823,882
1928	59,256,745
1929	58,218,154
1930	54,605,884
1931	45,630,695
1932	38,313,958
1933	38,647,846

A Catechism of Anthracite. Page 17. Anthracite Institute.

APPENDIX E



Anthracite vs. oil. Laboratory Bulletin Number 19. The Anthracite Institute. Part I.

APPENDIX F

Gallons of Oil Equivalent

to

Net Ton of Anthracite

(With various types of equipment and operation)

	Oil Conversion unit	Oil Boiler Burner Comb
At Average Operating Rating*		
Chestnut hand fired	185	185
Buckwheat stoker fired	169	169
Buckwheat magazine feed boiler	173	173

* This rating should be used for all seasonal comparisons.

Anthracite vs. oil. Laboratory Bulletin Number 19. Part II, Table No. 1. The Anthracite Institute.

APPENDIX G

Anthracite vs. Oil

Initial Cost of Equipment for Average Home

Equipment	Cost
CONVERSION EQUIPMENT (Does not include boiler)	
Anthracite stoker complete with thermostat	$350 to $450
Oil burner with 275 gal.tank* in cellar	498
" 550 " " buried	586
" 1000 " " "	616
" 1500 " " "	652
EQUIPMENT FOR NEW HOMES	
Approved automatic stoker with thermostat completely installed in cast iron boiler	$450 to $550
Magazine feed boiler with thermostat	200
Hand fired boiler with thermostat	140
" " " without "	100
Combination oil burner and boiler with 275 gal.tank* in cellar	673
" 550 " " buried	761
" 1000 " " "	791
" 1500 " " "	827

*Note: The equivalent capacity of 275, 550, 1000 and 1500 gallong tanks is 1½, 3, 5 3/4, and 8 tons of coal respectively.

Anthracite vs. oil. Laboratory Bulletin Number 19. Part II, Table No. 2. The Anthracite Institute.

APPENDIX H

Comparison of Operating Costs*

	Oil	Anthracite	
	Conversion	Hand Fired	Magazine Fired
FUEL COSTS			
Oil @ 6¢ per gallon	$111.00		
Chestnut @ $13 per ton		$130.00	
Buckwheat @ $8.50 per ton			$89.00
Gas @ $1.00 per M	3.50	0	0
Electricity @ 6¢ per kwh	10.00	0	0
FIXED CHARGES			
Depreciation 10%	$50.00	**	$20.00
Interests & Repairs 6%	30.00		12.00
Total	$204.50	$130.00	$121.00
Annual saving in favor of Anthracite		$74.50#	$63.50

* Based on residence consuming 10 tons of Chestnut Anthracite per year.

** It is assumed that this is a conversion job and that the owner has a boiler. Even if this is not so, fixed charges would be the same against both oil and Anthracite.

\# Savings will be increased in direct proportion as fuel used exceeds the equivalent of 10 tons.

Anthracite vs. oil. Laboratory Bulletin Number 19. Part II, Table No. 3. The Anthracite Institute.

APPENDIX I

Annual Cost of Heating

with

Anthracite and Oil

OIL		ANTHRACITE ANNUAL COST		
Price Per Gallon	Annual Cost	Price Per Ton	Hand Fired	Magazine Feed
4 1/8	$176.75	$7.00	$70.00	$114.75
4 1/4	181.50	7.50	75.00	112.50
5	186.00	8.00	80.00	116.75
5 1/4	190.50	8.50	85.00	121.00
5 1/2	195.25	9.00	90.00	126.25
5 3/4	200.00	9.50	95.00	131.50
6	204.50	10.00	100.00	136.75
6 1/4	209.00	10.50	105.00	142.00
6 1/2	214.00	11.00	110.00	147.25
6 3/4	218.50	11.50	115.00	152.50
7	223.00	12.00	120.00	157.75
7 1/4	227.75	12.50	125.00	163.00
7 1/2	232.50	13.00	130.00	
7 3/4	237.00	13.50	135.00	(Buck-
8	241.75	14.00	140.00	wheat
8 1/4	246.25	14.50	145.00	or Pea
8 1/2	251.00	15.00	150.00	Coal)
8 3/4	255.75	15.50	155.00	

Anthracite vs. oil. Laboratory Bulletin Number 19. Part II, Table No. 4. The Anthracite Institute.

APPENDIX J

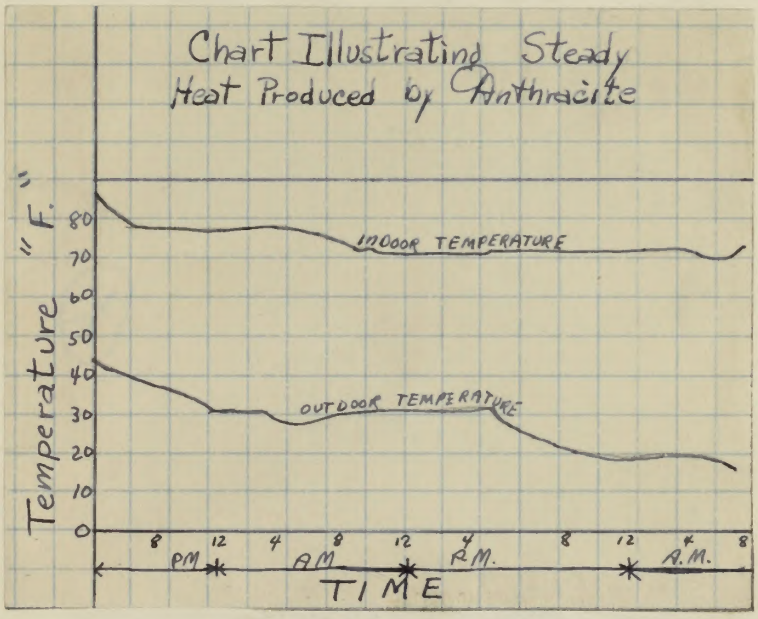
Price for Which Oil Must be Purchased in Order to Equal Cost of Heating with Anthracite. (Hand Fired).

Chestnut Anthracite Per Ton	Oil per Gallon (Cents)
$9.00	*
9.50	1/8
10.00	3/8
10.50	5/8
11.00	7/8
11.50	1 1/8
12.00	1 1/2
12.50	1 3/4
13.00	2
13.50	2 1/4
14.00	2 1/2
14.50	2 3/4
15.00	3

* Fixed charges alone greater than entire cost of heating with anthracite.

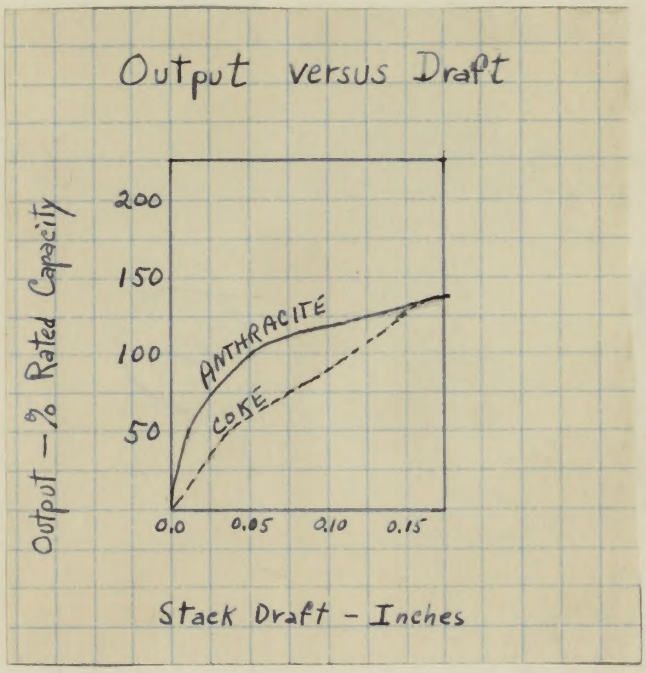
Anthracite vs. oil. Laboratory Bulletin Number 19. Part II, Table No. 5. The Anthracite Institute.

APPENDIX K



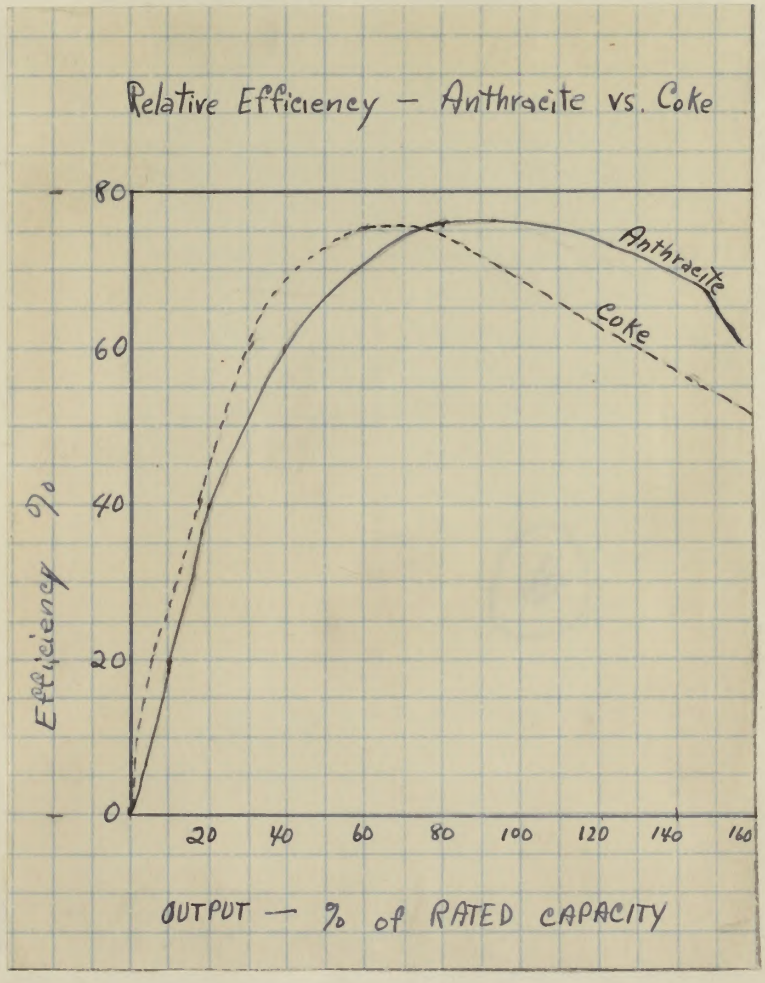
Anthracite vs. oil. Laboratory Bulletin Number 19. Part III. The Anthracite Institute.

APPENDIX L



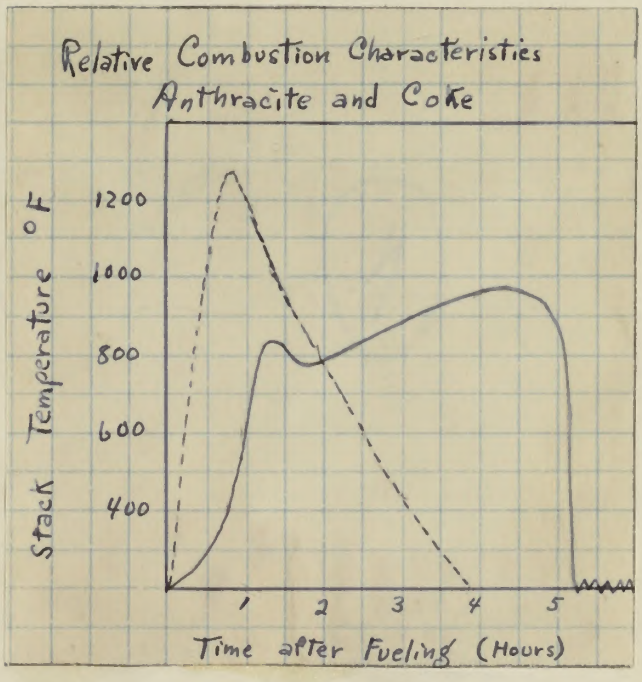
Anthracite vs. by-product coke. Laboratory Bulletin Number 17. The Anthracite Institute.

APPENDIX M



Anthracite vs. by-product coke. Laboratory Bulletin Number 17. The Anthracite Institute.

APPENDIX N



Anthracite vs. by-product coke. Laboratory Bulletin Number 17. The Anthracite Institute.

APPENDIX O

NUMBER OF FIRING PERIODS PER DAY*

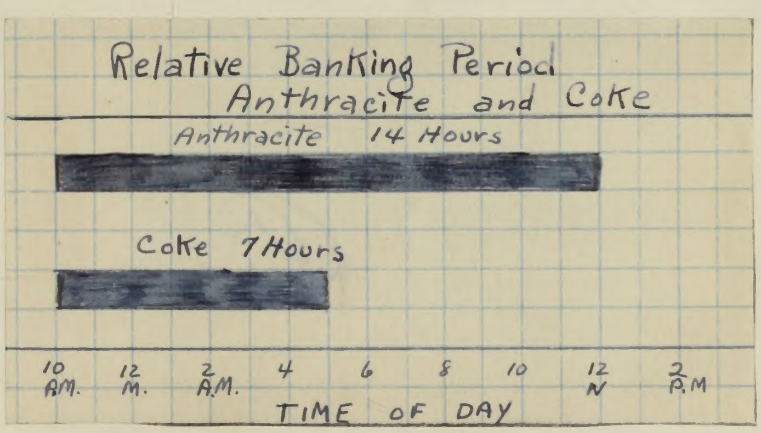
Exclusive of starting fire in morning and banking at night.

Operating Condition	Anthracite	Coke
Fuel level with bottom of door Dampers $\frac{3}{4}$ open	1	4
Fuel heaped to top of door Dampers $\frac{3}{4}$ open	1	2*
Fuel level with bottom of door Dampers open	4	9

While the practice of heaping coke in the furnace is shown to decrease the attention it should also be noted that the output of boiler was reduced to 75% of its normal value.

Anthracite vs. by-product coke. Laboratory Bulletin Number 17. The Anthracite Institute.

APPENDIX P



Anthracite vs. by-product coke. Laboratory Bulletin Number 17. The Anthracite Institute.

APPENDIX Q

Moisture Absorbed by Fuels

	Anthracite	Coke
Moisture absorbed per 100 lbs. dry fuel	2.25 lbs.	8.0 lbs.
Moisture absorbed per ton of dry fuel	45.lbs	160. lbs.

Anthracite vs. by-product coke. Laboratory Bulletin Number 17. The Anthracite Institute.

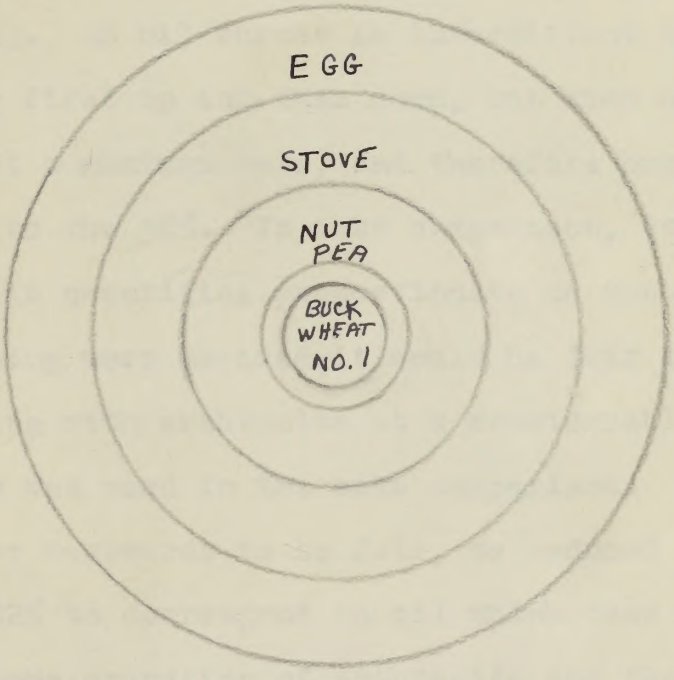
APPENDIX R

Distribution of Anthracite, All Sizes, by States

States	Per cent of Grand Total	
New England:		
Maine	.76	
New Hampshire	1.06	
Vermont	.58	
Massachusetts	8.04	
Rhode Island	.88	
Connecticutt	3.16	14.48
Atlantic:		
New York	35.99	
New Jersey	15.77	
Pennsylvania	21.12	
Delaware	.46	
Maryland	1.58	
District of Columbia	.76	
Virginia	.22	75.90
Central:		
Ohio	.36	
Indiana	.14	
Illinois	1.14	
Michigan	.67	2.31
Northwest:		
Wisconsin	1.39	
Minnesota	.54	
North Dakota	.04	
South Dakota	.05	2.02
Trans-Mississippi:		
Iowa	.15	
Missouri	.02	
Nebraska	.05	
Kansas	.004	.224
Southern:		
North Carolina	.011	
South Carolina	.022	
Georgia	.010	
Florida	.014	
West Virginia	.016	.073
Canada		4.993
Grand Total		100.000

The Story of Anthracite.Page 365. The Hudson Coal Co.

APPENDIX S



A Catechism of Anthracite. Page 10. Anthracite Institute Laboratory.

APPENDIX T

In discussing oil, the low percentage seemed more important. (See pages 86 and 101.) This divergence is noted and explained in this appendix.

"The combustion of oil, I might say also of gas, is an entirely different type of operation from that of coal burning. An oil burner is intermittent in its combustion, being first up and then down, but when on is always operating at a maximum rate, and therefore burning oil in proportion to the 32%. In coke comparison, coal and coke are burned in quantities proportionate to the weather. If hair-splitting were desired it would be fair to compare oil at 32% rating with anthracite at a considerably higher rating than was used in the coke comparison. However, in leaning over backwards to be fair, we reduced the anthracite rating to 32% to correspond to oil which does not reflect the continuous operation of anthracite and the intermittent operation (and wasteful operation) of oil." (1)

(1) Edward W. Parker, Director, Anthracite Bureau of Information. Anthracite Institute. (In a letter to the writer of this thesis, dated April 3,1935.)

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Anthracite and its competition

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